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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Porosity in Cast Iron.

As a basis for discussion, an article in the September number of *La Fonderie Moderne*, by Mons. Marcel Didier, on "Factors Influencing the Porosity of Cast Iron and How to Avoid it," presents much of interest.

Mons. Didier points out that porosity is due to the evil influence of gas, which penetrates the liquid metal or which is formed there through various reactions. These gases, he states, are principally composed of oxygen, nitrogen, carbon monoxide, and they naturally have a tendency to rise to the surface of the liquid metal in order to escape into the atmosphere, but often the iron freezes before the gases are completely eliminated. In the portion last to freeze there is a probability of finding numerous pockets or blowholes which are associated with large graphite areas or a highly-crystalline metallic structure due to the length of time taken to cool. This structure possesses poor cohesiveness owing to the large size of the grains and to the graphite plates which separate them.

It thus seems necessary to have a metal of normal cohesiveness, that is to say, a non-porous iron, in order to prevent the formation of large graphite plates and crystalline zones.

The following factors influence the porosity of cast iron: (1) Casting temperature; (2) crystallisation; (3) chemical composition; and (4) heat-treatment. Dealing with casting temperature, Mons. Didier insists that this is the principal factor in causing porosity, and adds that the hotter the metal the less chance there is of blowholes. Additionally slag inclusions, on account of the low density, have a chance to rise to the surface. A high temperature permits of the metal being in a state of chemical equilibrium, and prevents harmful internal tension.

The second factor, crystallisation, is dealt with by stating that when liquid iron cools the planes of crystallisation group themselves at right-angles to the walls of the mould. An extreme variation in contour of the walls has a profound influence on the crystalline system, and can produce irregularity associated with lines of least resistance. For this reason sharp angles and projections should be eliminated or reduced to a minimum. There is no exception to this rule. Large variations of thickness during cooling set up internal tensions, resulting in pulls and draws.

Of the elements entering into the chemical composition of iron, perhaps silicon has the greatest influence on the fluidity and hardness. As silicon facilitates the formation of graphite, incorporation should be kept within reasonable limits. Phosphorus increases fluidity of cast iron, lessens contraction, and reduces the likelihood of blowholes and inclusions. But, on the other hand, it produces large grain, with which is associated weakness and porosity. Up to 0.08 no bad effect should be experienced. Manganese hardens iron; it has, contrary to silicon, the property of hindering the formation of graphite. Chromium and titanium increase the hardness, give that fine grain so desirable in cast iron.

As to heat-treatment, it is stated that despite all precautions that may be taken during cooling, internal tensions are produced due to differences in the rate of cooling. To destroy these a reheating followed by slow cooling is necessary. This heat-treatment does not only break down the tensions, but also reduces the passive resistances which act against the homogeniety of the iron. This is very important when the castings have to be machined.

Numerous methods have been devised for closing up porous places, but a great number are more or less impirical. For instance, some foundries allow porous castings to soak for a period in a tank of urine. Mons. Didier points out that he does not wish to discuss the results obtained, but states that the process is scarcely scientific nor yet hygienic. He is of opinion that the best method is to copper porous castings by the electrolysis of a copper-sulphate solution. This process has the advantage of being simple, requires no special installation, cheap and within the scope of all foundrymen. It is noteworthy that the deposit of copper adheres quite firmly. The penetration into the pores can be helped by electrolysing under pressure.

We are of opinion that Mons. Didier has missed out one of the principal factors, that is, gating and running; but, as stated, his four factors certainly form an excellent base from which to tackle the proposition of porosity.

London Foundry Classes.

In the Department of Metallurgy at the Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C.3, a special course of instruction on "Foundry Practice" will be given during the Autumn and Lent terms by Mr. G. Patchin, A.R.S.M., M.I.M.M., and Mr. A. F. Gibbs.

The course will consist of lectures and demonstrations accompanied by practical work in moulding, core-making, and casting. The instruction will be of special value to metallurgists and those engaged in engineering and foundry work. The opening lecture of the course will be given on Monday, September 25, at 7 p.m.

The syllabus includes: Moulding sands; moulding boxes and tools; methods of moulding; cores and core-making; stoves and furnaces; temperature control; furnace tools; metals and alloys used—ferrous and non-ferrous—properties and composition; calculation of mixtures; cleaning and trimming of castings; annealing; faults—blowholes, cold shuts, porosity and drawing, scabbing, etc.; detection of faults—use of the microscope; general arrangement and design of the foundry; costing.

The laboratory work will include testing of moulding sands, measurement of temperatures, preparation of moulds and cores, casting in iron, brass, bronze, aluminium alloys, etc.

As the accommodation for practical work is limited, students may be admitted to the lectures only provided they can give satisfactory evidence of practical experience.

The fees for students resident in the administrative County of London and in the County of Middlesex are 20s. for lectures only, and for lectures and two evenings a week practical work, 30s.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

SMALL RUNNERS AND SOUND CASTINGS.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to your footnote, the idea that I intended to convey was that owing to the tendency of a small channel or runner to freeze quicker than a large runner, hotter metal *must* be used in the first place.

Secondly, with a large runner, the parts of the mould adjacent to that runner are receiving fresh supplies of heat in mass, which heat up these parts quickly to a temperature never possible with a small stream of metal. This tendency of the large runner to superheat the mould at the point where it enters, producing either open or spongy metal, and feeding or other methods must be made to counteract the effects. This action of the runner is specially noticeable in the case of small but comparatively weighty flywheels. If, for convenience or otherwise, the metal is allowed to enter by the rim, by the greater difficulty in balancing them, this being due to the metal of the casting near the runner being less dense than in other parts of the casting.

Regarding the extraction of heat from a small channel, although the surface area of a small channel comparing a ½ in. sq. channel with a 1 in. sq. runner, being respectively 2 in. and 4 in., the smaller channel has only ¼ sq. in. of sectional area, as against 1 sq. in. of sectional area in the larger channel, so that *proportionately* the small channel has double the wall or surface area of the larger one. In other words, although the actual wall area is as 2:4, the capacity is as 1:4. This tendency of a small runner to freeze is recognised in making light castings, when a large runner would be dangerous to remove, by the provision of heat retainers similar to those referred to by the writer, and placed quite close to the casting. Although the writer drew attention to the fact several years ago, it is not common knowledge, so far as moulders are concerned, that ½ in. square is not the same as ¼ sq. in., a fact that has led to a few errors in some foundries.

Assuming the extraction of heat in the case of ½ in. sq. and 1 in. sq. were relatively equal, there would still, at some period during solidification, be a central portion approximately ½ in. sq. (still more or less fluid and surrounded by a wall of already solidified metal) in the case of the 1 in. sq. runner.—Yours, etc.,

"ECOSSAIS."

The Price of German Castings.

According to a communication sent by the Commercial Secretary at Cologne, forwarded to the Department of Overseas Trade, the German Fittings Association has increased the surcharge for malleable castings with effect as from August 23 to 3,800 per cent. The prices for wrought-iron fittings are increased from the same day by 50 per cent. net. The Association of German Iron Foundries, Giessereiverband, has increased the prices for castings by 70 per cent. as from September 1. The prices for cast-iron socket pipes and pipe fittings were increased by 75 per cent., for cast-iron fall pipes also by 75 per cent.

Pig-Iron.—The pig-iron prices fixed at the last meeting of the Pig-Iron Committee of the Eisenwirtschaftsbund for deliveries as from September 1, now that the coke price increase has been taken into consideration, are as follows:—Hematite, 29,784; steel-making pig, low in copper, 29,116; foundry pig-iron I., 25,575; foundry pig-iron III., 25,505; foundry pig-iron, Luxemburg quality, 23,818; Siegerland steel-making pig, 27,543; and spiegeleisen, 8-10 per cent., 30,133 Mks. per ton.

A Note on Venting.

By J. S. SHEPHERD.

The writer recently had some toothwheels castings to make, and the foreman lay stress with his instructions to use ground sand. His orders were carried out, but the results were a failure; the sand would draw up with the tooth. Eventually the following procedure was successfully adopted: Equal quantities of ordinary facing sand was mixed with black sand. After placing the moulding box in position upon the odd side or pattern plate, sieve the facing sand upon the pattern sufficiently to cover it, then fill up the box with black sand and ram round the pattern. Fill in more sand and ram again until the box is ready to flat-ram, but instead of using the flat rammer, pat the sand down with the hands and then strike off in the usual way. This is the point where the writer claims that the trouble arises. Before turning over the box—or, if on a moulding machine, drawing the pattern plate—push a tube through the back of the mould down to the core print, and withdraw the sand, any size that is smaller in diameter than the print of the core. This allows the air to get in the mould as the pattern is being drawn, and prevents the formation of a vacuum, which is, in the writer's opinion, the cause of the bad draw. The same applies to core-making. If pattern-makers would bore a small hole in any print or position where the core-maker could easily fill in after drawing the box, there would only be the deadweight and friction of the box to overcome.

Although many construct collapsible coreboxes and patterns, they are not necessarily an advantage, as the loose pieces may warp or get lost, and the screwed variety are constantly requiring fresh holes and screws.

Birmingham Metallurgical Society.

The opening meeting will be held at the Chamber of Commerce, Birmingham, on Wednesday evening, October 4, at 7.15 p.m., when the President, Mr. A. J. G. Smout, will deliver his inaugural address on "Waste and Inefficiency in the Metal Industry." This will be followed at regular intervals to the end of April with papers by some of the leading authorities in the iron and steel and metal industries. Copies of the syllabus may be obtained on application to the Secretary of the Society, Chamber of Commerce Buildings.

An Apprenticeship Course in Foundry Practice—X.

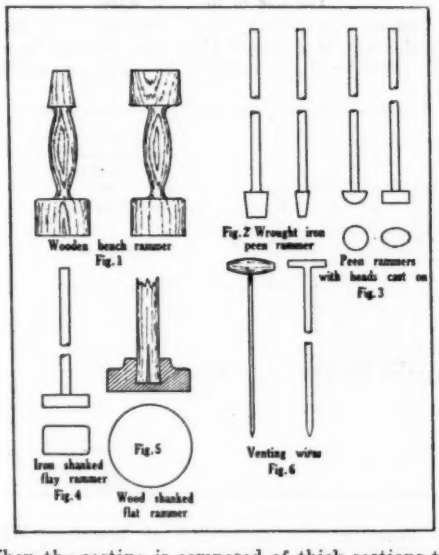
By Ben Shaw and James Edgar.

RAMMING AND VENTING SAND MOULDS.

With the exception of those that are made in loam, moulds are generally formed by consolidating the sand about the pattern. The process is known as ramming. This compression of the sand is essential in order that the mould will have body and strength to maintain the shape given to it on the withdrawal of the pattern and to resist the pressure of the metal.

Relative Density.

The degree of density given to the sand has an important bearing on the success of the resulting casting, and it must be varied to suit the design of the casting to be made, the kind of metal used, and the class of mould to be formed. Moulds for castings which are deep should be rammed harder towards the bottom to withstand the greater pressure of the metal, and, as a rule, the sand must be rammed more lightly for thin castings to enable air and gases generated to escape readily without injury to the casting.



When the casting is composed of thick sections the sand can be rammed harder, and, as the metal remains fluid for a longer period, any slight back pressure of gases upon the surface is compensated by the pressure of the metal. The ramming is varied in some moulds when the contraction of the metal to be cast in them is likely to be impeded, thus, though the face of the mould may be well rammed, it may be advisable to reduce the density of the sand behind it. Generally speaking, cast metals are "hot short," that is, they are weak when hot and castings are easily fractured in that condition; and, as some metals, such as cast steel and aluminium, contract quickly immediately following the point of solidification, it is necessary to ram lightly so that the contracting influence of the metal will be greater than the resistance offered by the mould. But stronger moulds are needed for steel than for aluminium, because it is a heavier metal, and, in a liquid state, it exerts relatively more pressure; therefore, moulds to receive aluminium should be lightly rammed, while those for steel should be well rammed, and precautions, other than ramming, should be taken to weaken the mould when the design of the casting demands it. Moulds for brass need not be rammed very hard, although more than is necessary for aluminium; but more care is necessary for bronzes, particularly phosphor bronzes, because they are more searching in their character and more readily penetrate the interstices between the sand grains when they are in a fluid state. For such metals the moulds should be more dense at the face, but only the face sand, the backing sand being rammed lighter so that the mould will vent better. There is room for more scope in the ramming of moulds to receive cast iron because it expands at the point of solidification and it does not contract so much as the metals previously mentioned. Under similar conditions, and with slight modifications, such as have been referred to, we consider that the varying density between moulds for varying metals should be in the following order—aluminium, brass, bronze, cast iron, and cast steel, the former being the more lightly rammed.

Ramming Green and Dry Sand Moulds.

The class of mould that is being prepared has a very important bearing on the degree of density of the sand. Thus greater care and relatively lighter ramming are necessary in the preparation of moulds in green sand than in dry sand. A considerable amount of steam is generated in green-sand moulds, and if the sand is tightly packed the pore space is reduced and the permeability of the mould decreased, with the result that the metal may offer less resistance to its escape than the mould, with, generally, disastrous results to the casting. In dry-sand moulding however, the bulk of the moisture is evaporated, leaving little steam to be released. When the mould is dried it is left more porous. A dry-sand mould can therefore be rammed to greater density than a green-sand mould, other conditions being equal.

Ramming Needs Experience.

Considerable skill is necessary to ram moulds successfully. To the uninitiated it looks a comparatively simple operation, and apparently anyone could ram a mould; but everyone cannot vary the degree of density required to suit the work that is being moulded, which only experience can determine, particularly for green-sand moulds. Practice, too, is needed to acquire what might be termed the sense of touch. A dry-sand moulder transferred to green-sand work generally experiences difficulty with the ramming of the sand, and some time may elapse before he acquires the necessary manipulative skill; that is one of the reasons for making dry-sand and green-sand moulding distinct branches. As a rule more experience is necessary for ramming green-sand moulds, but it must be remembered that difficult work is passed on to the dry-sand moulder because of the greater risk in producing a good, sound casting in green sand; thus, there are other factors to be considered before the relative skill required in these branches of moulding can be given their correct perspective.

In machine-moulding the sand is, to a considerable extent, consolidated by mechanical power with which we shall deal when considering machine-moulding; but, in the formation of the general run of work, hand ramming is resorted to.

Ramming Tools.

The tools used for compressing the sand are termed rammers, and they are divided into two types, though there are many variations of each type. They are known as the peen, pegging, or pin rammer and the flat rammer, and in large work the moulder makes use of his feet for compressing the sand. For ordinary bench work, particularly in the brass foundry, a wooden hand rammer is frequently employed, such as is shown in Fig. 1. Both ends are used, that which is chamfered off being the peen rammer, the other being the flat rammer. Iron rammers are more frequently used for floor work, and their lengths vary according to whether the ramming is done by the moulder kneeling or standing. Usually peen rammers are made from $\frac{3}{4}$-in. or $\frac{7}{8}$-in. round iron with one end jumped up or having a bit welded on to form the peen, Fig. 2, although

some have the peen cast on, as shown in Fig. 3. It is the more general practice for flat rammers to be cast on shanks or handles, and the metal is usually rectangular or circular in shape as in Fig. 4. Wood shanks may be used instead of iron, but they should not penetrate the face of the rammer; instead, the rammer should have a tapered hole cast in it and the handle secured with a secret wedge, as in Fig. 5. There are other forms of rammers in use, some being tipped with rubber to prevent damage to the patterns should they come in contact with them, while many pneumatic rammers operated by hand are in use. Ramming a mould, especially if of large size, is undoubtedly a laborious job, and mechanical rammers are an acquisition when the necessary facilities are available for installing them. Pneumatic rammers are easily controlled, and varying pressures can be applied according to the needs of the work, to an extent comparable with hand ramming. When hand ramming must be resorted to, rammers, particularly flat rammers, should be warmed to prevent sand adhering to them during the process, otherwise the labour involved is increased.

Method in Ramming.

In the process of ramming a mould the peen rammer is used first, and its use is continued to compress the sand following the contour of the pattern, and a flat rammer used for the backing sand; but for shallow moulds, which have the minimum of support, the peen rammer should be used completely to ram up the box part, the flat rammer only being used after the box is full and before the surplus sand has been strickled off. This is necessary, because the sand is added gradually, and each addition is rammed separately, and the peen rammer being smaller is less likely to form a joint from which the next layer of sand may separate than a flat rammer. It must be remembered that, although the peen rammer should be used as near to the vertical sides of a pattern as is possible, without touching the pattern, for some classes of work, the operation needs considerable care to obtain a regular density; hard places on the mould surface will cause the casting to scab, due to the resistance offered to the escape of gases, while soft places will give under the pressure of the metal and show swells on the casting. Generally the rammer should be applied about an inch or more from the pattern, the compression of the sand on the face of the mould is then more likely to be regular, an important consideration with all sand moulds, but more especially with green-sand moulds.

Venting.

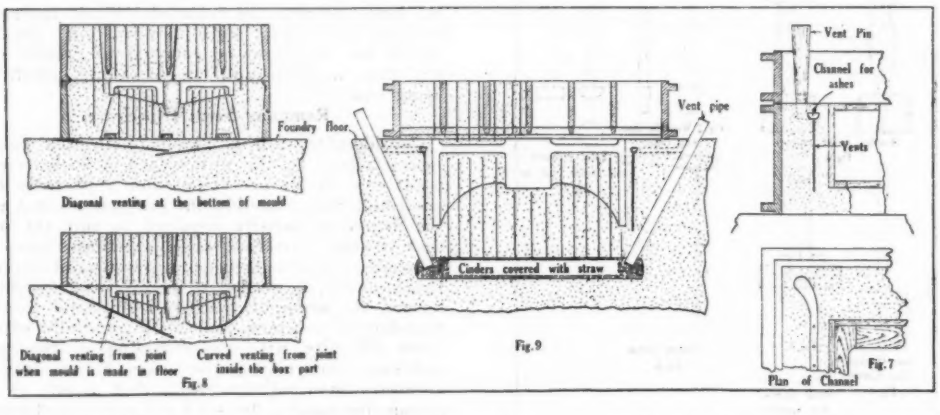
The density of the mould should be such that, besides having strength to resist the momentum and pressure of the molten metal, it is sufficiently open in texture to enable gases to escape quickly without detriment to the casting This combination of strength and permeability of the mould is most difficult to obtain in green-sand work, and as the mould must be rammed to suit the possible pressure of the metal, the porosity of the sand is assisted by artificial means and is known as venting. The venting of moulds is capable of very wide interpretation, but, for the time being, we purpose considering it in connection with sand-moulding only. The escape of air and gases from a mould must be provided for, and many waster castings can be traced to the ineffectual provision made. Not only do vents in a mould provide a means of escape, but they determine the direction in which the escape is to be made because the current of escaping steam or other gases along the vents tends to draw similar gases through the pores of the sand in the same direction. Vents have been referred to as the safety valves of the mould, and this very aptly describes their value.

Vent Wires.

In small moulds the vents are usually made by thin wire about $\frac{1}{8}$-in. dia., while as the size increases $\frac{1}{4}$-in. or even $\frac{1}{2}$-in. dia. vent wires may be used. The small vent wire is about 12 in. long, having, generally, a wood handle; the larger type is longer with an iron T handle, both of which are illustrated in Fig. 6. Venting, however, is not confined to the use of vent wires; wood or straw, rope, hay, ashes, or waxed string may be employed according to the shape and size of the casting to be made.

The Use of the Vent Wire.

Generally speaking, more venting is necessary on the top of a mould than the bottom, because the pressure of the metal is less and not so likely to overcome the resistance of gases. When moulds are small and are made in boxes the vent wire should be applied from the outside after the pattern has been rammed up and before it is withdrawn. The vent wire need not come in contact with the pattern, as it destroys the pattern, and they are of little value if the metal is sufficiently fluid to fill them; if they are within $\frac{1}{2}$ in. or $\frac{3}{4}$ in. of the pattern they will suffice, because the influence of the molten metal on the backing sand causes the vents to draw gases from the face of the mould and through the intervening thickness of sand. When venting is done from both top and bottom of the mould it should be laid on a softened bed of sand to be cast to allow the free escape of gases through the bottom. Some moulds need to be vented from the joint of the mould as well as from the top. This is best accomplished by ramming up in the usual way and venting the cope from the top, and when the cope has been removed, the vent wire is used from the joint into the drag about 1 in. to 2 in. away from the pattern and at intervals of from 2 in. to 3 in. Frequently these vents are connected on the joint and directed to the edges of the box part. When the drag part is made in the foundry floor it must be vented from the joint, though sometimes it is done from outside the cope box.



Venting Deep Moulds.

Deep moulds should have larger vents, either directed downwards or upwards as circumstances require, and small vents may be used to direct the gases towards the larger vents. The larger vents should be connected by means of a channel

cut in the sand and preferably just below the top joint, as shown in Fig. 7. Some moulders prefer to make the connecting channel on the top joint, but metal is more likely to find an entrance and probably fill the vents and be a source of danger. The channel should be carried to a convenient corner of the box either to provide an exit from the side of the box, or, if that is impossible, in order to ram a vent stick in a convenient part of the cope. The channel should be filled with ashes—sometimes straw rope is used—and sand rammed over the top to form the joint. When the cope box has been located a vent stick should be introduced to connect the vent with outside. This is drawn when the cope is made. It is important to make sure that the connection is clear, and when the cope is finally lowered into position the vent should be loosely filled with straw, and at the time of casting it should be fired.

Wax Vents.

The use of wax vents is more applicable to cores of an intricate nature, but occasionally there is a need for their use in parts of moulds which would be weakened by the use of the vent wire, or so difficult of access that they could not be vented with any degree of security otherwise than by introducing wax vents. Wax wire is used for this purpose, either composed wholly of wax or of wax having a centre of string. The heat of the hand is sufficient to make it pliable without breaking or cracking, and in that condition it can be introduced at suitable places during the time of ramming up a mould. They are associated with dry-sand moulding, the heat given to them when being dried melting the wax, which is absorbed by the surrounding sand, and thus venting the mould. The wax wire should be connected to the main vents or so directed that free exits for gases is assured.

Igniting Escaping Gases.

Firing the gases escaping from vents during the time of pouring prevents an explosion which will take place to a more or less extent when the gas does take fire from the heat of the mould. The gas is similar to the dreaded fire-damp of coal mines, and is known as carbonic oxide or carbon monoxide (CO). When an explosion is allowed to occur about the mould it may affect the casting, especially in a greensand mould. Parts of the mould may be shaken out of position either before the mould has been completely filled or before the metal solidifies, and however small the disturbance may be, it may result in a waster casting.

Venting Flat Moulds.

When the mould is flat diagonal vents should be made from the joint, and the vent wire may be bent in order to direct it towards the underside of the pattern, or side vents may be used according to whether the mould is made in or above the foundry floor, and after the pattern is removed, connecting vents should be made through the face of the mould as long as care is taken in sleeking sand in the vents at the face to prevent metal entering. This method of venting is illustrated in Fig. 8. Generally, when the foundry floor is used for large flat work, or when the underside is recessed, it is better to make a cinder bed under the mould, forming an escape chamber to which vents are directed, and either ramming up vent sticks connecting the chamber with the outside or introducing pipes through which the gases will escape. An example is illustrated in Fig. 9 which shows the use of a cinder bed for venting purposes. In this case the drag is vented downwards, but the cope is vented direct through the top. The depth of a cinder bed should be about 3 in. or 4 in., and in some cases more, depending upon the amount of concavity of the required casting; in any case, it should not be less than 3 in., and the cinders used should be riddled to exclude fine ashes. It is of course necessary to prepare this cinder bed before the pattern is finally located and the contact made with the pipes or vent sticks. The former should be plugged with waste or straw to prevent sand entering while making the mould. The top of the chamber should be from 3 in. to 6 in. below the lowest part of the pattern, depending upon the size of the work, and the vents are made into it from the mould surface after the pattern has been withdrawn, as in Fig. 9. After cinders have been introduced into the chamber, it is a good practice to cover it with a layer of straw before the covering sand is applied, so that sand will be excluded from the cinder bed.

General Considerations.

It must be remembered that a fine sand requires more venting than a coarse sand, as also does the moulds for thin castings; and when hard ramming is necessary special attention must be given to the venting because the metal is not likely to lie quietly against a hard-rammed surface unless the gases which would prevent it doing so have a quick means of escape through the sand. The same may be said with reference to sand which is too damp in green-sand moulding or too strong in dry-sand moulding. The vents made about the vertical sides of a deep mould should be parallel with the sides and not directed towards them, as vents may penetrate into the mould and leave small, weak portions of sand which are likely to be blown into the mould if they are overlooked by the pressure of escaping gases. In the higher parts of a mould vents may penetrate the surface; in some cases it is advantageous that they should do so, notably in small castings of brass, when it is either not possible or desirable to have risers, a needle vent may be used to free the metal from pressure so that it will rise and fill the mould. This precaution is not exceptional to brasses or bronzes, it is also applicable to steel, aluminium, and, to a certain extent, cast iron. A misrun may be caused through the head of metal being insufficient or the metal may not be hot enough; in either case, however, needle vents assist the complete filling of the mould by freeing the metal from pressure. The brasses and bronzes have less fluidity; they set quickly, and are affected to a greater extent than other metals by the back pressure of gases if there is not sufficient head on the metal. Live metal adjusts itself more readily to any temporary back pressure from gases than a metal low in temperature, because it retains its fluidity longer. The successful production of castings depends largely upon what might almost be termed minor details in the formation of their moulds, for which the moulder is entirely responsible, and not the least of these is ramming and venting the mould to suit the varying conditions involved.

American Pig-Iron Output, 1922.

According to Special Statistical Bulletin No. 4, 1922, issued by the American Iron and Steel Institute, the output of pig-iron in the United States during the first half of 1922 (as compared with the corresponding half of 1921 in brackets) was as follows, in long tons of 2,240 lbs., according to the grades:—Basic, 6,389,876 (4,504,431); Bessemer and low-phosphorus pig-iron, 3,512,604 (3,280,072); foundry iron and ferro-silicon, 1,629,229 (1,375,399); malleable pig-iron, 427,998 (165,522); forge, 102,884 (48,937); spiegeleisen and ferro-manganese, 96,555 (136,269); all other grades, 31,865 (20,351); total iron made for sale or for use, 12,191,011 (9,530,981) long tons.

According to the fuel used, the half-yearly outputs were as follows:—Coke pig-iron, including ferro-alloys made with or without coke by electricity, 12,106,225 (9,448,223); anthracite, including anthracite mixed with coke, nil (12,823); charcoal iron, 84,786 (69,935) tons.

The total number of furnaces in blast on June 30 last was 201 out of a total of 450, as against 125 in blast on December 31, 1921.

THE NORTH SOMERSET ENGINEERING COMPANY, LIMITED, is being wound up voluntarily. Mr. D. Owen, 47, Milsom Street, Bath, has been appointed liquidator.

Foundry Refractories.*

By H. Winterton.

Dr. Stansbie, in *Iron and Steel*, defines refractory materials used for metallurgical purposes as "bodies that can be exposed to the furnace temperatures for which they are used without softening or disintegration." This sums up in a single sentence the secret of "Foundry Refractories." The author has for many years past been engaged in the task of preparing and handling various materials having for their object the minimising of the moulders' anxieties in his endeavour to produce castings which should be free from rough blemishes. Eminently satisfactory results have sometimes been obtained, occasionally at the cost of a minimum of experiment and consideration, but on other occasions the result of costly experiments and the expenditure of much valuable time has had but negative results so far as the advancement of the problems were concerned.

Generally speaking, however, foundry refractories may be divided into three classes—viz., acid, basic, and neutral. The first-named is usually of service in steel foundries, and the two latter in iron foundries. Included in the former are various silicates, while in the basic section are magnesite, bauxite, and other materials of like nature, some of them far too expensive to be thought of in connection with castings for one moment. Graphite should be considered a neutral refractory, as it is neither basic nor acid.

Siliceous Refractories.

Practical men have sometimes found that acid-forming oxide, when heated and in contact with basic oxides, unites with them to form silicates, which, though in some proportions more fusible than the silica itself, yet on being mixed in other proportions raises the fusing point, and thus at once renders it of a higher commercial value for the purposes we have under notice. These exact proportions are not discovered without much patience and experiment, and even then the end of the task is not reached, for varying castings of different densities require special treatment in their manufacture. These remarks respecting silica refer principally to steel-foundry practice, but not a few ironfounders occasionally make use of acid refractories when confronted with a huge mould which has to be cast at a great heat. The practice is, however, not general, and is not very likely to be much adopted. Possibly one reason for this is the ever-varying proportions of the silicates upon which founders have to rely. The position of affairs when war broke out in 1914 was that for many years a large number of steel foundries had obtained their sand from Belgium, and at first it was thought no efficient substitute could be found. However, close research was carried out into British silica formations, and it is interesting to note that not only was the British product found to do the work as well as its foreign competitor, but that it could be produced cheaper. The steel moulder cannot concede too much attention to the all-important question of refractories, for his work is carried out at a much higher temperature than that of the ironfounder. His ever-present carefulness and close attention to the question of refractories is therefore quite understandable. His risk is great and the loss to the foundry, should a large steel casting be consigned to the scrap heap, is a very considerable item.

The Question of Sands.

It is not intended to deal in an exhaustive manner with this branch of the subject, except only as far as it relates specifically to the main subject under notice. Probably in a large number of cases the question of the refractory in its relation to the sand used is not sufficiently considered. With coal dust, at any rate in the past, it has been a case of one of the youngest boys being entrusted with the task of producing enough black sand for his mate's day's work, with all too little thought to the nature of his job. The porosity of the sand, its properties in relation to silica, oxides or alumina, were phases of the question which never troubled the lad, and the resultant day's output must necessarily have been disappointing, to say the least of it. How fallacious such a doctrine must have been is proved by the fact that to-day in quite a large number of foundries the day's mixture is in the hands of men who have made a special study of the question, and in a good many foundries to-day it is not an unusual thing to hear the physical properties of the sand discussed with considerable vigour and not a little theoretical enlightenment. The reason for this is that some technical schools have recognised the importance of the students being instructed in this department of the industry. It would be well-nigh impossible to make a different mixture for every individual job, but the importance of much more care being bestowed in this department than has hitherto been the case in a large number of foundries cannot be too strongly emphasised. However, in common fairness to the ingredients in use and to the skill of the manufacturer in the making of facings, considerable care should be exercised in the various proportions used. The mixtures should be weighed or measured, and careful note taken of particular results obtained under varying conditions. The porosity of the sand, the moisture present—always a delicate point—the grist of the coal dust, the fusibility or ultra-refractory nature of the old sand, and other points equally important, should be marked and instructions issued for variations accordingly. In a word, this branch of the art of moulding should be as thoroughly studied as the mixtures of iron which are to be put in the cupola.

Coal Dust.

The connection between the refractories and the moulding sand is easily traceable. Coal dust is used because if the sand were unsupported the molten metal would fuse the surface, and the result would be a rough, blemished casting. This fusing is caused by the alumina and oxides necessarily present in the sand as binding agents. The oxidation of the coal dust causes the presence of carbonic oxide or carbon dioxide gas, and this provides the necessary protection when the metal is in a molten condition. Not only, therefore, is it necessary that no little care should be taken in the selection of the sand used in the foundry, but it is equally essential that the supply of coal dust should be carefully watched. The porosity of the sand is a considerable factor of determination, but there are other points, notably the size of the finished casting, its purpose, whether for machining or not, etc., which should also weigh with the foundryman. In selecting coal dust for use in the foundry, care must be taken to inquire into its bituminous qualities, its ash content, its volatile matter, and, of course, its proportion of fixed carbon. No hard-and-fast rule can be laid down with regard to these variables and their proportions, for experience has taught that few men think exactly alike on this subject. It is perfectly safe to say, however, that too great a proportion of ash is most deleterious, and if used can only result in castings of a whitey-grey appearance with a particularly rough surface, and probably contaminated with sand burnt. On the other hand, if a coal of too high a carbon content be used, with a necessarily low ash percentage, the facing becomes of too refractory a nature, and the coal dust is unable to carry out the functions for which its application was intended. In this, as in many other matters pertaining to the foundry, circumstances govern in different cases, and from the practical point of view the correct mixture can only be found after various experiments.

* A Paper read before the East Midlands Branch of the Institution of British Foundrymen.

Grist.

Another matter of importance is the grist of the coal dust. If it is important to keep an eye on the porosity of the sand, surely it is equally important to watch the grist to which the men have been accustomed to use for their different tasks. It is very necessary to vary the grists according to the class of casting required from each shop, and also in consideration of the grade of sand used. This is a feature which is not always accorded the attention it deserves. For very light castings a coal dust of an exceedingly fine mesh is desirable, especially if the sand has an open tendency, while a slightly coarser yet still fine grist should be used for heavier work. The medium and coarse grades will be required for the larger classes of castings, in which it is necessary for the gases engendered to be carried away quickly, while the provision of a skin to the casting is left to a large extent to the blackings. A superfine coal dust is essential for light castings. On account of the lightness of metal the gases have not been overpowering, while the comparatively low temperature of the light body of iron has been sufficient to fuse the minute coal particles and thus give the fine surface coupled with easy stripping. Following up the early remarks with regard to the functions of coal dust, the many complaints emanating from the foundry might be eliminated if care were taken to see that the grist of the coal dust suited not only the sand but also the class of casting for which it is used. When coal dust of too coarse a grade is used, small "pits" are left on the face of the casting when cooled, and these are easily distinguishable by their formation from those indentations caused by particles of sand insufficiently milled. The application of heat from the molten metal to the small particles of coal forms a gas, as has been previously indicated. The gas in excessive quantities—excessive in consequence of the size of the particles—takes the line of least resistance, the soft molten metal, and the result is the "pits" which are too frequently seen in the finished article. Where larger castings are concerned the heavier weight of metal and the consequent increase in temperature prevents such indentations, particularly as the coatings of blacking on big moulds is generally more pronounced, and, in fact, is applied with a particular object in view.

Lime in Sand Causes Defects.

But it must not be thought that every blemish on the face of a casting or a great deal of the scabbing is due to the coal dust. As a matter of fact, there is no trade in which what may be called "luck" enters so largely. How else can certain mysterious happenings in every foundry be accounted for. Yet though some of the happenings in foundries may be classed as mysterious, it must be admitted that there is frequently a reason for many of the strange events. The author's attention was one day called by the owner of a fairly big foundry in the Birmingham district to some peculiar rusty-looking specks on his castings. Both he and his manager were positive that the imperfection was due to the coal dust, though it seemed strange that the trouble only happened in one part of the shop. Later, however, the trouble spread through all the shops, and then it seemed certain that the coal dust was to blame. Still not satisfied, further inquiries were made, and eventually it was established beyond question that the trouble was really due to the presence of lime particles in the sand. Again, it has been proved time after time that scabs on castings have been due to excessive moisture in the mould. Faulty castings, too, are sometimes caused by indifferent ramming, but possibly this may be a libel. Modern foundry practice tends all in the direction of power mixers, of which there are several good British designs on the market. In making a selection, however, considerable care must be exercised, and after all few will be found to do the work better than a hefty labourer with a shovel and the knowledge how to make use of it with effect, though the output would be greatly accelerated. As to the actual mixtures, every individual foundryman has his own personal ideas on the subject, based upon sound practical experience. Local circumstances, such as the class of castings made, sand mixing, quality of coal dust, and the exigencies of the moment, bear largely upon this point, and no one could possibly be a better judge of actual requirements on the spot.

Blackings.

Blackings or facings may be divided and subdivided into various classes, and again into various sections. The old-fashioned idea of blacking moulds, with all and sundry compounds, many of them of doubtful efficiency, some of them most evil-smelling, and not a few positively deleterious to the castings, seems to be rapidly disappearing, and in many foundries to-day the preparation of cores and moulds is carried out with the utmost care. It is outside the province of the Paper, however, to do more than refer to the various kinds of facings that have been produced to meet the demands of practical men whose experience of refractories far exceed that of a generation ago, at any rate so far as can be ascertained from existing records. Even to-day, however, there are foundrymen who hold that our forbears were little behind present-day founders in the production of castings, and really when one inspects castings turned out a century ago one cannot fail to be filled with amazement and astonishment that, with the crude methods of handling at their disposal, the old-time founders were able to produce such remarkably clever work. Within even easy recollection, however, the facing of moulds was a matter in which the rule-of-thumb methods were wont to prevail. The provision of a tub in a corner of the shop into which stale beer and other even less palatable liquids were placed, together with a few handsful of ground charcoal, will be within the recollection of most foundrymen. There seems to exist in the minds of some people the idea that anything will do as a facing or blacking for a mould. Never was there a greater fallacy. A treatise on foundry practice contains a recommendation to mix coal dust as a facing. If foundrymen want a little more trouble in their shops than they already have it is suggested that they take the advice given. Present-day methods have proved that a refractory much nearer the specific gravity of water than coal proves the best facing—in fact, one of the worst facings for high temperatures is a mixture of coal dust. The modern foundryman demands various facings suitable for the particular class of casting upon which he is engaged, care being taken to bear in mind the thickness of metal, the heat of the molten iron, and the general characteristics of the finished casting. Hence it has been established that for light castings nothing exceeds in efficiency a charcoal blacking of good quality, though expert practical men are not quite in agreement as whether a pure wood-charcoal or one slightly stiffened with a mineral admixture produces the better results. Some foundries go even further. For instance, two light-casting foundries have mixed a special facing to their own formula, and these in their turn differ to a marked degree in essential particulars. Certain it is that both these foundries enjoy a high reputation for the excellence of their castings, while the proprietor of one assured the writer that since introducing the new method he had experienced far less trouble in his fettling shop and had a considerably reduced outlay under that head. For ordinary green sand work which requires sleeking there are now prepared many mineral blackings, sometimes called "patent," which gladden the eyes of the moulder and assist to bring out a casting with that beautiful blue glossy skin so much sought after by founders. The true functions of these facings are reflected by this very anxiety of the founder. He knows that, given a good highly refractory substance, the pores on the face of the casting will be closed up, and therefore the utility of the skin does not end with the colour. He knows, too, with a blacking of the right character the cleaning off or fettling of the casting is going to be a matter of comparative simplicity, and this remark applies not only to green sand, but also to loam, dry sand, and core work. It is necessary to have a stronger,

or, as it is termed, heavier facing for the larger castings because not only has the weight to be considered, but the casting temperature in large moulds becomes a serious factor. Hence it is necessary to provide a strong refractory in which the percentage of carbon grows higher in accordance with the strain sought to be put upon it. It is on this very point that theory weakens, and where this happens, as occasionally it may, it becomes necessary to search for the real reason. On the face of the previous remarks, it might be thought that to get good results in every case it would only be necessary to raise the carbon content. But this is not all that is required. Some refractories are of so harsh a character as to preclude all thought of sleeking on a green sand mould or mixing with water or clay wash in a boss, especially when newly prepared. It is here that the skill of the blender is required, and by his agency devious facings are produced which can be held to cover all classes of moulds. In many instances it has been found that the slightest modifications of mixtures have made all the difference between a good-looking casting and a bad one. It is only seeking trouble to make use of a facing that does not possess refractory characteristics to a high degree to face a mould of considerable size which is to be cast at a high temperature. On the other hand, the presence in the blacking of too great a proportion of siliceous matter would cause infinite trouble in the way of scabbing and burning. But as previously indicated, the use of a high refractory for light castings is not usually advisable. For cores a sound refractory must be used, but the necessity of providing something that will not easily rub off after baking must be kept clearly in view. Here, again, the task of the expert has been to provide an article which will perform its work perfectly under varying circumstances, and the labour of the fettling shop has been very considerably modified in the past few years.

Graphitic Facings.

Graphitic facings may be divided into three parts, and roughly classed as plumbago, graphite, and blacklead. There are very many qualities, but it is more or less again a matter of carbon content, and those who are satisfied with the commoner kinds must not expect to obtain such good results as other founders who endeavour to procure the highest grades. Here once more the question of individual practical test comes to the front.

During the war many founders discovered to what a large extent we were dependent upon our overseas possessions for the provision of some of the grades of plumbago.

Several cargoes on the way to this country from Ceylon were intercepted by German submarines and sunk. But we have now come to an end of that particular trouble, and importations have been resumed, though not quite on the old lines. One unfortunate circumstance—unfortunate, that is, from the foundry point of view—is that as a result of war shortage the shipper discovered how useful an article he had been previously carrying at a low rate. As a direct result it is questionable whether the freightage on any other individual article of commerce rose in anything like so large a percentage as the rate on plumbago. Under these circumstances it will be obvious that a return to pre-war costs in the matter of refractory compositions involving the use of this class of goods must necessarily be somewhat slow if the old high quality is to be maintained.

DISCUSSION.

As the discussion consisted of a number of questions, the sense of it is covered by MR. WINTERTON'S reply, who said he was very pleased his remarks had given rise to such a number of questions. It showed the subject was one which needed serious attention. With regard to the mixture of 1-10th silica and 9-10ths plumbago it would be a costly mixture, and not likely to come into general use. He was very careful to lay it down as an essential fact that practical demonstration in nine cases out of ten was the only way out of a difficulty. But breaking away from the general rule he would say, in reply to the Chairman (Mr. Evans) that ¼ of a part of plumbago, 4 parts red sand, 1 part ganister, 3 parts of steel paint, would really be a silica paint. He thought he would find it would solve the difficulty, as he had a similar problem a little time ago.

With regard to Mr. Bunting's remarks on soapstone in plumbago, it all depended whether the plumbago one is requiring is of pure character or whether one is prepared to have a cheaper quality, and as a matter of fact get worse results and use more of it. That is really what it comes to. Insist upon the best quality; naturally the cost will be more at first, but the work will be very much more satisfactory, and one will use far less of it if the moulder can be persuaded not to waste it. With regard to small castings, these, in some cases, are a question of local practice. There are thousands of small castings cast beautifully clean with good coal-dust and a good mixture of fat. As to appearance the slightest dusting of plumbago will give the skin of the casting a better appearance. Mr. Stevenson does not apparently think that the appearance of the casting has very much to do with it. He agreed that to a practical man and to practical machine men in many cases the appearance of the casting indicates nothing, but in many cases some of these castings have to be sold, and if one can show a man something which looks very nice sometimes faults are not found out.

In answer to Mr. Grant, if he were dusting blacking on small castings he would give only a suspicion of best plumbago. With regard to Mr. Goodwin's remarks, he certainly thought it was superfluous to put a lot of blacking on a good many of the small moulds. Some small castings can be made without blacking, although a suspicion of dusting of plumbago certainly improved the appearance. With regard to the larger castings, it would be futile to attempt to pour heavy iron into an unblacked mould and expect it to come out without an enormous amount of work.

Mr. Russell spoke about a sand for use in steel. He did not pretend to recommend any particular kind of sand or any particular kind of facing. He dealt in the abstract, but he would be very pleased to give the further information privately of sands which are declared to be far better than Belgian, or at any rate its equal. He had not made much experiment with lead castings, but if Mr. Russell would make his mould a little finer and closer a good deal of the trouble would disappear.

With regard to blue glossy castings, he still adhered to his opinion that whilst the presence of that skin on the casting is, in many cases, of no actual use, but when it is desired to sell the casting it is going to be of value by pleasing the customer. He agreed with Mr. Pemberton that manufacturers of facings should give instructions. There was no question to-day facings could be obtained which meet the requirements of each individual job. He knew a firm which made 27 different brands of blacking, each one different from its fellow, and each in use for a different purpose, and that firm could tell the customer exactly how that blacking should be used to get the best results, what weight it would be safe to use, etc. That, certainly, was a step in the right direction. He felt this research would be continued, and it would be possible shortly to get a particular facing to suit any particular casting. With regard to coal-dust of too high carbon content, it necessarily followed that the volatiles would be lower, and as volatiles were required for the casting to fend off the iron, one must necessarily have a refractory if the volatiles were absent. In conclusion, Mr. Winterton said everything he had mentioned had been verified by testing and analysis.

MR. PEMBERTON moved a vote of thanks for the lecture and able way the discussion was answered.

MR. J. LUCAS seconded, and the PRESIDENT supported.

In reply, MR. WINTERTON said it was a great pleasure to come to Loughborough. He was very glad the paper had roused such discussion, for it was a healthy sign of life, not only in the foundry trade but for the Branch.

THE MILLOM AND ASKAM HEMATITE IRON COMPANY, LIMITED, put another furnace into blast at their works at Millom, Cumberland, last week.

The History of Loam Moulding in the Liege District.

MR. VARLET ANSWERS HIS CRITICS.

Mr. Varlet, answering Messrs. Gallon and S. G. Smith, writes that he thanks these gentlemen for the interest they have taken in the Paper which he read at the Birmingham Conference, and desires to place on record his deep regret that he was only allowed twelve pages in which to deal with so exhaustive a subject, for he would have liked to have outlined the subject in all

FIG. 1.—FINISHED CORE FOR SLAG POT.

its phases instead of being limited to four types of casting. With regard to Mr. Gallon's remarks, he would say that the workmen of the Liége district are undoubtedly very clever, especially as regards loam moulding. It is perfectly true that one man can make a 3½-ton slag pot in 18 hrs. This period is quite average when, say, three are ordered. It should be mentioned that the mould and core are made in masonry and last for three castings as set out in the paper. As regards the hole, chiselled out of the base plate for taking the strickle, a translation error has crept in. This plate is cast around the stem of the strickle, which is first doped with tar. This stem is suspended in the mould with iron wire. As soon as the metal is frozen, the arm is lifted out and given a quarter turn twisting motion, this being done before the contraction of the casting takes place.

Dealing with Mr. S. G. Smith's discussion, Mr. Varlet states that he is in agreement with him

FIG. 2.—THE CORE REMOVED FIVE HOURS AFTER CASTING.

that loam moulding can be either cheap or expensive according to the methods adopted and the type of casting to be made. He remarked in his paper that the old loam moulders, who had little equipment, were quicker than present-day workers, and that certain castings were more quickly made in loam than in sand. Mr. Smith will perhaps be astonished when told that in 1890 the St. Léonard concern of Liége made a series of six locomotive cylinders in loam, and that the cost price was lower than when made in sand. But as stated in the paper, the contrary is often true.

Composition of Loam.

As regards the pipes made by Mr. Smith, he regretted that he could not enter into a discussion on this question, especially as to length of time taken. He found Mr. Smith's figures excellent, but he wished to state that the subject of the Paper presented was "The Origin of Loam Moulding in the Province of Liége" associated with its actual methods of working, and is not, to his mind, a comparison with those of other countries. Tannery waste, mentioned under the heading of "mixtures," is bark, either oak or chestnut, which when reduced to small lammellæ of 2 to 5 cm. long is used for the tanning

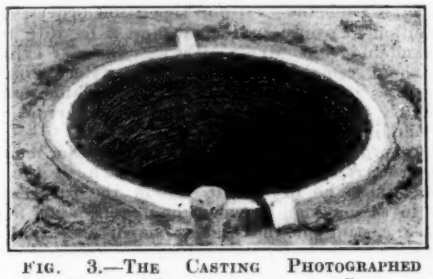


FIG. 3.—THE CASTING PHOTOGRAPHED AFTER THE WITHDRAWAL OF THE CORE.

of hides and skins. Sand No. 1 (mortier de sable) is a mixture normally used in Belgian foundries. It includes horse litter, and not exactly dung. Horse litter has quite special properties. It is above all an excellent binder, giving high plasticity to the sand on account of the fatty and ammoniacal materials present. Further, because of the considerable straw and oat content, a high degree of porosity is given to the sand allowing of the easy escape of gas. It should be stated that it is rather expensive, and when, as it occasionally happens, it is replaced by sawdust, different results are given.

Flywheel Moulding.

He was again in complete agreement with Mr. Smith that the best method of mould flywheels is to assemble the whole in a box, and that is what is always practised in Belgium for flywheels

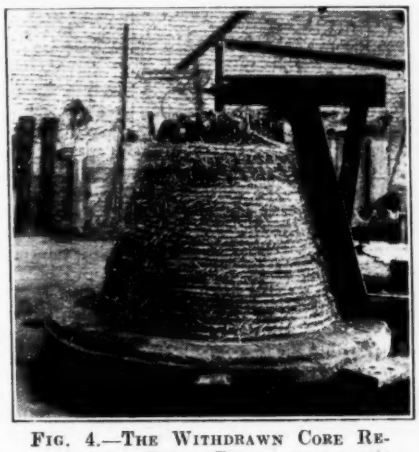


FIG. 4.—THE WITHDRAWN CORE REMADE WITH STRAW ROPE AND—ON THE TOP—COKE. IT IS NOW READY FOR STRICKLING.

up to 5 metres dia. But for larger wheels he insisted that the method outlined in the paper is more rapid, for no boxes are used for such large diameters. Moreover, consideration should be given to the small number of reinforcements that are used for a flywheel of 6 to 7 metres dia. compared with the method outlined by Mr. Smith in THE FOUNDRY TRADE JOURNAL of May 25, 1922.

Unfortunately, he has not one of these castings on order; it would be a pleasure for him to invite Mr. Smith to do him the honour of visit-

ing Belgium and ask him to compare the two methods of moulding outlined. Mr. Smith could then judge for himself as to whether the method of working was the most economical, the quickest and easiest, and also could examine the numerous details mentioned as to the success of the casting.

Cylinders.

Having dealt with the loam moulding of a cylinder of 2½ metres dia., 22 mm. thick, and 2½ in. high, he affirmed this was an easy casting to mould, but its complete success requires some amount of care. Mr. Smith must excuse the author if he has forgotten to say that this type of mould does not apply to repetition work, but only to an isolated casting. Up to now, he had only turned out three, and these of different diameters. They were not for an outside order.

It is probably that for repetition orders special equipment would be devised, and it is quite understandable that Mr. Smith has cast 50 cylinders without remaking the masonry. Regarding the feeding head, this is quite well explained in the sketch (see Fig. 4, No. 14) by an arrow. One alone is sufficient.

In praising the superiority of the loam moulder, he referred to those he had known in the past and those he desired to see in the future—that is to say, a man to whom one can confide a plan of a casting of the highest importance and who moulds it perfectly without having recourse to the help or the advice of anybody. He found that

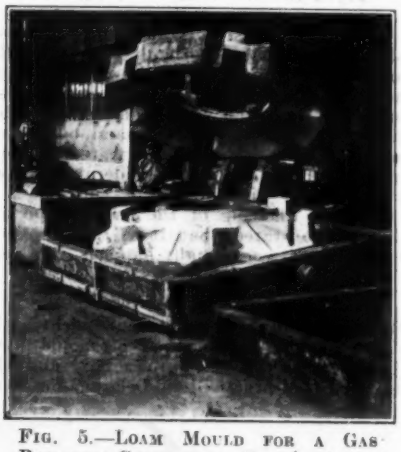


FIG. 5.—LOAM MOULD FOR A GAS PRODUCER GRATE TO BE CAST IN STEEL.

the moulder had to apply himself with all his power to imagine the construction of the mould, whilst the dry-sand moulder is usually provided with a pattern for the production of his casting. It was not possible for the writer to compare the British and Belgian moulder, for he had not the opportunity to visit a foundry during his stay in Birmingham. This is to be regretted, for he imagined that some very interesting methods of working are practised in England, and he further thought that all foundrymen ought to spread the knowledge of any methods which they find advantageous and to help foundry progress by every possible means.

When the Congress and Exhibition was held in Liége in 1921, all the visitors were invited to inspect the four most important Belgian foundries: Messrs. John Cockerill, A. Ketin, Compagnie des Conduites, and Esperance-Longdoz. The visitors expressed themselves as delighted with the opportunity afforded.

Generally speaking, Belgians are always happy to show their work, for they consider all foundrymen as friends. They looked upon the recent visit of Mr. V. C. Faulkner, the Editor of THE FOUNDRY TRADE JOURNAL, when passing through Liége, as a distinct honour, and he hoped on the occasion of the next Belgian Conference to see the members of the Institution of British Foundrymen, who, he assured in advance with all possible sincerity, would be accorded the same hearty welcome which he had received in Birmingham, and which is one of his most pleasant memories.

In sending his answer to the criticisms on his Paper, Mr. Varlet enclosed five photographs which are distributed amongst the text, being self-explanatory, except perhaps Fig. 5, which has reference to a mould for a gas-producer grate. This mould was struck up in loam, no pattern being available. It was closed up and taken a considerable distance to another part of the works to be cast in steel.

Paris 1923 International Congress.

Under the caption of "French Foundrymen Seek International Meeting," the latest number of *The Foundry* to reach England states that C. E. Hoyt, secretary of the American Foundrymen's Association, has received a formal invitation from the Association Technique de Fonderie de France to participate with the Institution of British Foundrymen and the Belgian Foundrymen's Association in a comprehensive international foundrymen's congress and exhibition to be held in Paris under the auspices of the French Association during the first two weeks in September next year (1923).

The French Foundrymen's Association has been completely reorganised since the war, and its membership now includes all of the prominent foundry industries in France. Through its efforts the Ministere de l'Enseignement Technique has loaned the buildings of the Ecole Nationale d'Arts and Metiers at 151, Boulevard de l'Hopital, where the convention and exhibition will be held. These buildings are particularly suited to this purpose. The school foundry, which is completely equipped, will be available for holding competitions and making demonstrations.

The invitations will be acted upon by the American Foundrymen's Association at the next meeting of its board of directors in September, and it is understood that arrangements will be made by the American Foundrymen's Association to insure adequate representation and attendance from the United States.

Society of German Foundrymen.

At the general meeting of the above Society, held from June 9 to 12 (the proceedings of which are reported in a recent issue of "Stahl und Eisen"), ENGINEER HUBERT HERMANN read a Paper on the use of "baby" Bessemer plants, especially of the duplex type, and on recent practical experience with German duplex plants. Among other points, he mentioned the advantages of the Zenzes small converter, the essential feature of which is that the body of the converter and the blast box are separate one from the other. The advantage of this is that the converter proper can be quickly replaced or renewed, thus saving considerable "shut-down" costs. It is now possible with this type of converter to blow metal obtained in the open-hearth furnace from steel scrap, and so work independently of the expensive hematite pig. The silicon required for supplying the proper amount of heat for the bath is obtained by adding ferro-silicon to the converter. In this way it has become possible to use the converter process in open-hearth steelworks which have no cupola furnaces, and to produce very light castings at a lower cost than hitherto, which could only be done in the electric furnace.

At the same meeting DR. E. H. SCHULZ dealt with the question of organisation in foundry and metallurgical practice generally, referring (1) to the importance of proper arrangements for testing raw materials and finished castings—points now being considered by the Institution of British Foundrymen, (2) to the necessity of closer co-operation between the mechanical testing laboratory and the works in clearing up points relating to unsatisfactory material, (3) to improved equipment for laboratories, and the necessity for separating the mechanical and chemical sections of the test laboratory, (4) to the organisation of the latter, etc. In connection with the research department, the author emphasised the necessity of a thorough system of bibliography and filing records, together with a properly indexed system of abstracts from foreign books, periodicals, and patent specifications.

The Reichert Metallurgical Microscope.

In the investigation of metals, microscopic examination is the most important adjunct to chemical analysis, for whilst the latter only furnishes information respecting the nature and amount of the constituents present, microscopic examination throws light upon the effects which a given mechanical or thermal treatment, or, the admixture of foreign substances, may have upon the structure, and therefore the physical properties of metals and alloys.

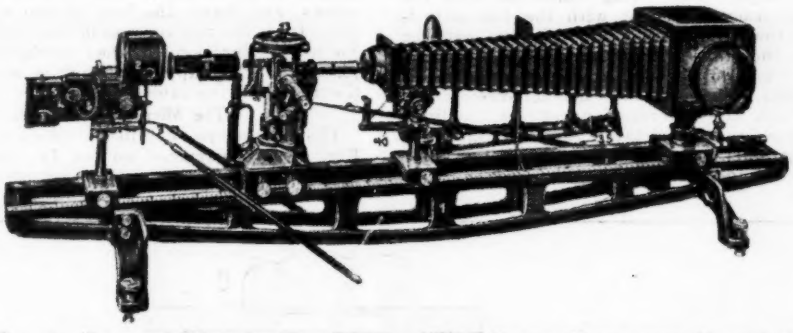


FIG. 1.—REICHERT METALLURGICAL BENCH. WITH DIRECT VISION FROM 30 TO 1,500 DIAS. ARE OBTAINED, BUT WITH THE CAMERA THE RANGE IS FROM 1 TO 5,000 DIAS.

Metallurgical microscopes differ in construction and characteristics from ordinary microscopes in conformity with their specialised use. They find their most important application in the control of manufacturing processes concerned with the production in working of metals, and also in testing the character and value of materials, concerning which microscopic views of the structure of the materials afford exhaustive information.

A photographic camera in conjunction with the microscope enables these structural images to be recorded in a permanent form, thus furnishing valuable evidence for the use of the consignor and the consignee. For the sorting out and rejection of defective materials it is of the greatest use.

At the present time, when the costs of materials and production have risen so enormously, such a means of safeguarding and controlling manufacturing processes is of the utmost importance, and no foundry in which the quality of the materials is an important factor, can afford to dispense with the use of metallographic methods and the metallurgical microscope.

In addition it is essential in mines, steelworks, rolling mills, factories engaged in the production of machine tools, armaments, munitions, locomotives and rolling stock, automobiles, aircraft and electric lamps, shipbuilding yards, military and other national undertakings, also for railway material, etc., it is obviously necessary also in technical institutes for teaching and research.

In view of the importance of metallurgical microscopes, the Reichert concern, who are represented in this country by Messrs. O. C. Rudolph and Beesley, of 65, Margaret Street, Oxford Circus, London, W.1., have given particular attention to this branch of manufacture, and a special department has been formed at their works, which, as the result of years of experience, produces instruments specially adapted for the ends in view.

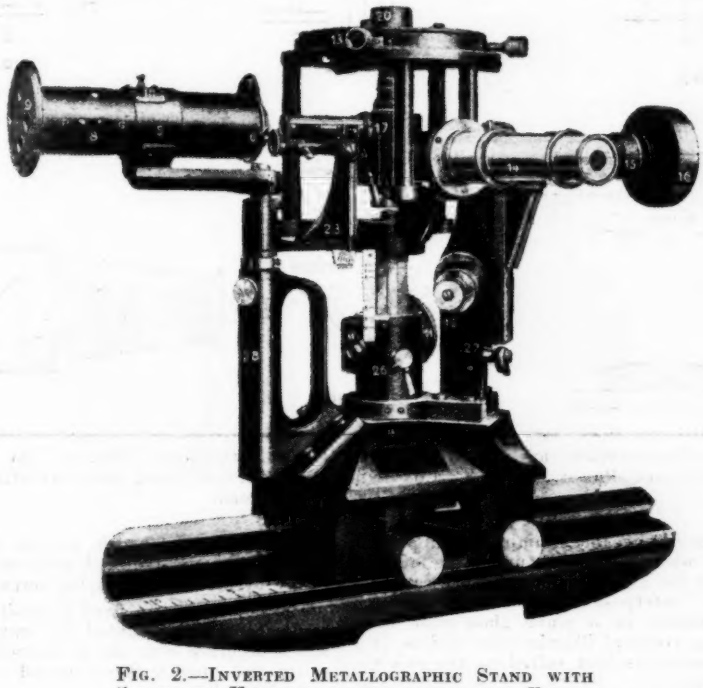


FIG. 2.—INVERTED METALLOGRAPHIC STAND WITH SELECTIVE VERTICAL ILLUMINATION BY EITHER PRISM OR PLANE GLASS REFLECTOR.

The "Reichert" metallurgical microscope (Fig. 1) which it is proposed to describe in this article, consists of the following principal parts:—(*a*) Large optical bench (1); (*b*) lamp (2); (*c*) microscope (4); (*d*) camera (32); (*e*) apparatus for macrophotography for the production of comprehensive images under low magnification (40).

Special Advantages.

The following points may be specially noted:—

1. The convenient arrangement of the object-stage (Fig. 1, No. 13) which on the one hand allows of observations of objects varying greatly in size and shape, and on the other hand requires only one face of the object to be ground, this face being laid in contact with the object-stage whereby it is automatically orientated at right angles to the axis of the objective.

2. The coarse and fine adjustments are independent, the object stage being connected with the coarse adjustment but not with the fine adjustment, so that relatively heavy objects can be placed on the stage without any strain upon the delicate thread of the micrometer screw.

3. The fine adjustment does not act directly but only through the intervention of an inclined plane, whereby the delicacy and stability of adjustment, particularly necessary in photographic work, are attained.

4. A novel interchangeable illumination apparatus by means of which the object, under the lowest as well as under the highest magnifications can be illuminated by interposition of either prism (oblique illumination) or a plane glass plate inclined to 45 deg. (vertical illumination) whichever form of illumination is best suited to the object under observation.

5. An instantaneous change over from direct visual observation to photographic fixation of a microscopic image by the simple manipulation of a handle which effects the rotation of a prism 90 deg.

6. The fine adjustment of the illuminating prism is effected by a micrometer screw, in connection with which a pointer movable over a scale shows the correct adjustment for every objective. This ensures the rapid and certain attainment of the correct illumination in all cases.

7. A mirror device in the camera enables the photographic image to be observed conveniently on the ground glass plate of the camera until just before the exposure, whilst the operator remains in the same position as for the direct visual observation of the microscopic image, so that he does not need to move from the latter position to check the focussing of the photographic image.

8. Separate accommodation of the auxiliary appliances for macro-photographic apparatus is made on a small prismatic rail attached to the side of the large optical bench. These appliances are always in a position for use, on the rail, and can at any moment be brought into operation in place of the microscope.

A very stable optical bench, which covers an area of 18 by 80 in., is supported on four levelling screws, and forms the base of the whole apparatus. It should rest on a table free from vibration. To avoid vibration in steel works and the like places the whole apparatus may be suspended from the roof by wire cables.

The Microscope Proper.

The microscope, details of which are shown in Fig. 2, is constructed on the Le Chatelier principle. The massive base (4) is adapted to the profile of the optical bench, so that it can be moved with ease to any required position, and then fixed firmly by means of clamping screws. .

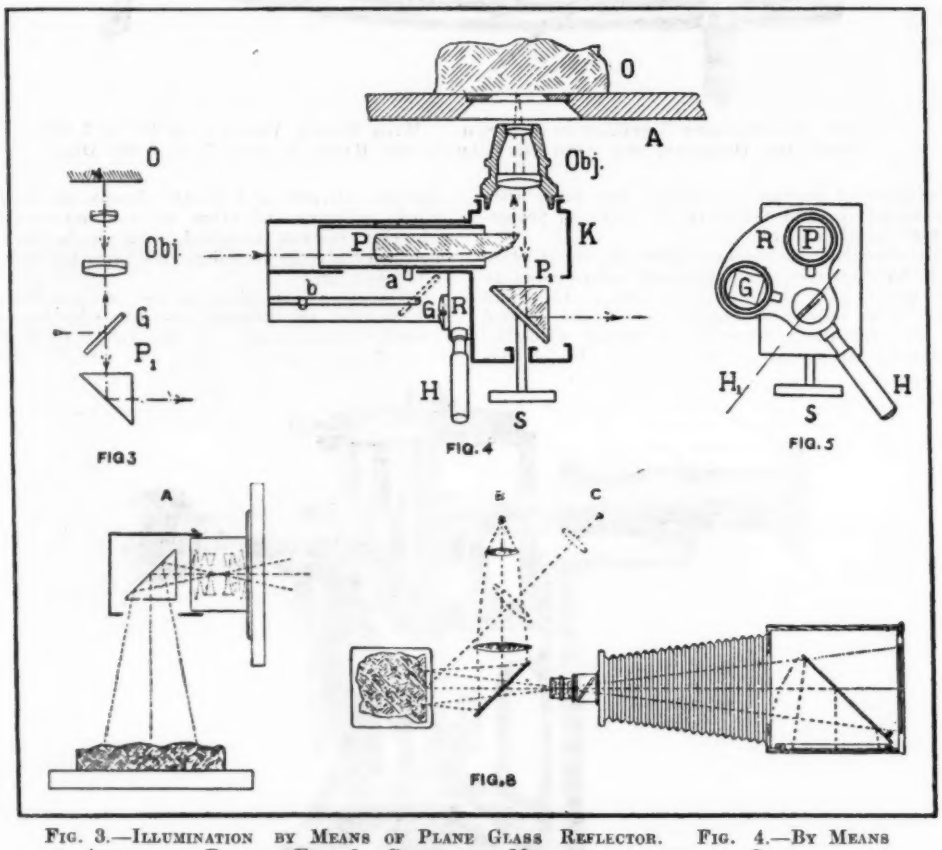


FIG. 3.—ILLUMINATION BY MEANS OF PLANE GLASS REFLECTOR. FIG. 4.—BY MEANS OF ADJUSTABLE PRISM. FIG. 8.—CONVENIENT MOUNTING OF BOTH AND OBVIATING ANY DISTURBING OF THE SPECIMEN.

The objectives are fixed in position by a spring clamp, and are mounted in centrable collars by which accurate centring is assured. They can be easily and quickly interchanged by means of attached handles.

The course adjustment is effected by raising or lowering the object-stage by rack and pinion. It may be fixed by clamping screws (26) in order to prevent any change in the adjustment when heavy objects are on the stage. The scale shows the correct position of each objective, thus facilitating rapid adjustment.

The object stage is supported by four pillars, is circular and rotatable, and can also be displaced in two directions at right angles to each other by a sliding motion actuated by micrometer screws and fitted millimetre scales (reading to 0.1 mm. by means of a vernier gauge) and a registering device to enable any particular part of an object to be brought into the field whenever required.

The fine adjustment (12) of the image is effected by means of a special vertical prism guide on which a very carefully finished micrometer screw works.

The fine adjustment (12) is the same as in the Reichert biological microscope stands, and was adapted because it has proved specially suitable for photo-micrographic work. The adjustments can be read off to within 0.002 mm. on a graduated drum.

The prism guide of the fine adjustment forms at the same time the support for the casing (17) which contains the finer optical parts of the microscope, together with the tube (14) and (15) connected therewith.

A column (28) attached to one side of the microscope base (4) is shaped so as to form a handle by which the microscope may be carried. It supports the illuminating tube (5).

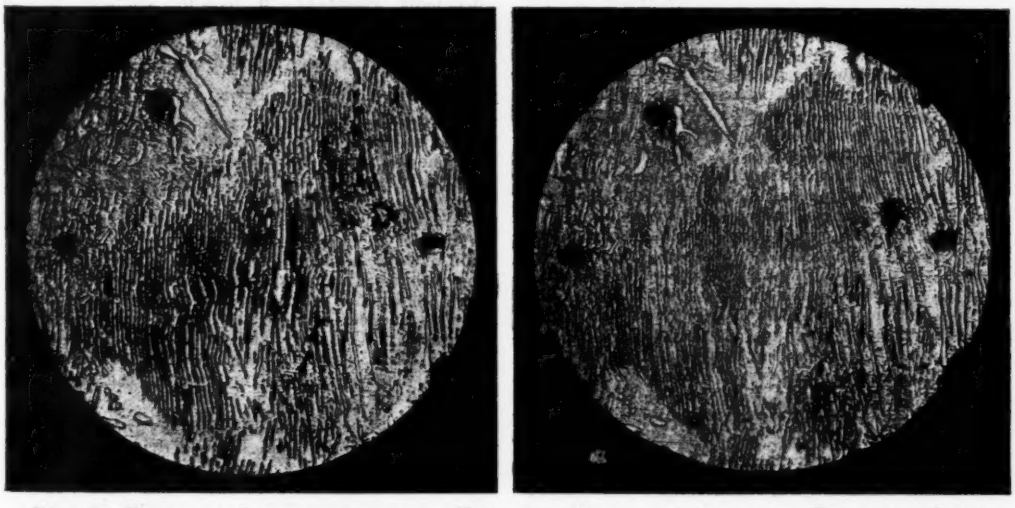


FIG. 6.—MICROS OF IDENTICAL SPOT OF A STEEL SPECIMEN BY MEANS OF THE PRISM AND PLANE GLASS REFLECTOR, THE FORMER, IN THIS CASE, YIELDING STRONGER CONTRASTS AND THE LATTER FINER DETAIL.

Path of the Light Rays.

The rays from the lamp (2) (see Fig. 1) have first to pass through the illuminating tube (5) (see Fig. 2). The rotating disc stop (9) on this tube has a number of orifices of different size by which the intensity of the illumination may be varied. The light rays are rendered convergent by the illuminating lens. Slots (10) serve for the insertion of a coloured glass and for a filter cell.

After emerging from the illuminating tube the rays arrive at the interchangeable illuminating apparatus and are deflected thereby into the objective, which in this case acts also as a condenser, concentrating the light on the object to be observed. The interchanging apparatus bears two small horizontal tubes, one of which contains a prism P (Fig. 4), and the other a thin plate of glass G, with parallel sides fixed at an angle of 45 deg. (Figs. 3 and 4). By means of a handle H (Figs. 4 and 5) either the prism P or the glass plate G can be interposed at will for the illumination of the same object and without bringing the object out of focus.

According to the magnification employed and the character of the object, the prism will be found preferable in some cases and the glass plate in others. Owing to the peculiar shape of the prism, which covers one half of the objective, rays reflected at the free surface of the lenses of the objective are excluded. The images obtained when the prism is used show therefore very pronounced contrasts, and are very brilliant owing to the complete reflection of the illuminating beam by the prism. Moreover, the light is directed obliquely on the object, so that differences in the height (relief) of different parts of the object are distinctly perceptible. The position of the prism must be adjusted in a horizontal direction according to the focal length of the objective in use. This is effected by means of a micrometer screw which actuates a pointer (23, Fig. 2). The tip of this pointer moves over a scale on which the correct position of the prism for every objective is indicated. When the plane glass plate is used the whole aperture of the objective is effective. The glass plate is therefore specially suitable for the resolving of minute details of an image under high magnification (Pearlite-structure).

The iris-diaphragm (6, Fig. 2) in the illuminating tube serves to accentuate contrasts in the image when the glass plate is used.

The rays of light thrown back from the surface

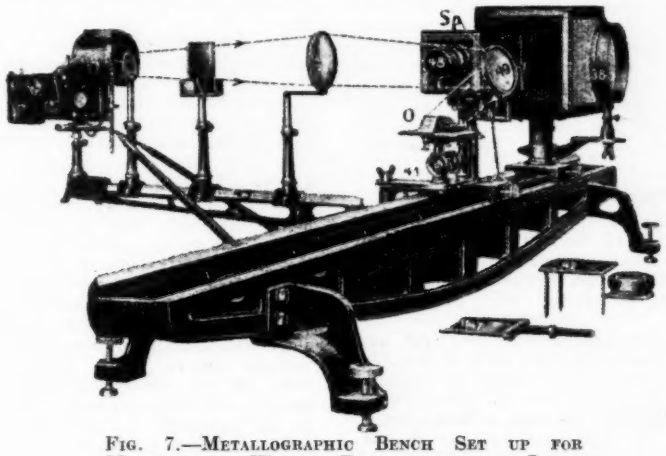


FIG. 7.—METALLOGRAPHIC BENCH SET UP FOR MACROGRAPHIC WORK. (PHOTOGRAPHING OF LARGE SECTIONS UNDER LOW MAGNIFICATION.)

of the object, in-so-far as they enter the objective, give rise to the image. They are deflected through 90 deg. by the image prism P_1 (Figs. 3 and 4). This prism is itself rotatable through 90 deg. by means of the knob S (Figs. 4 and 5). When the prism is in one of its limiting positions, the light rays are deflected either into the observation tube (14, Fig. 2) provided with an eyepiece in which the observer looks, or into the camera tube (15) which has a light proof connection with the camera through the tubular casing (16). In the camera tube a projection eyepiece is used, the front lens of which is screwed out more or less according to the length of the camera, so that the image of the focussing screen or photographic plate appears sharply defined when it has already been sharply focussed through the observation tube. The graduations on the projection eyepiece enable the position of the eye lens corresponding to any given camera-length to be ascertained.

The camera has a maximum extension of 80 in. It is provided with a reflex focussing arrangement (Fig. 8), when the mirror is set at 45 deg., the rays are reflected on to the focussing screen (33, Fig. 1) at the side. This enables the operator to control the image on the focussing screen from his seat at the microscope or to show it to several persons at once. A Hooke's key (35, Fig. 1) for focussing from a distance therewith in this case to actuate the micrometer screw. An observation lens (38, Fig. 1) enables the image to be conveniently examined as a whole, in order to ascertain that it is distinct and uniformly illuminated in all parts.

Objectives.

Since in metallurgical microscopes the object is not provided with a cover glass as in ordinary microscopic work, and since the length of the microscope tube in the former case differs from that in ordinary microscopes (250 mm.) owing to the different methods of illumination, objectives of medium and high powers must be specially constructed to correspond with these conditions, and objectives of ordinary microscopes therefore cannot be used.

In consequence of the one-sided use of an objective when the prism is used for illumination, in which case only one half of the aperture of the objective is utilised for the formation of the image, it appears desirable to employ the most highly corrected and perfectly constructed apochromatic objectives or at least fluorite objectives.

In making a selection it is necessary to bear in mind that a high magnification is only of value if it is accompanied by an increase in the angle of aperture of the objective, *i.e.*, an increase in the numerical aperture, for on this factor alone does the resolving power of the microscope depend.

If the numerical aperture is too small, so-called empty magnifications are obtained which do not allow of the resolution of the fine structural details.

Micro-Photography.

The Reichert metallographic bench carries at its centre a prismatic third rail, pivoted at one end so that it can be swung round 180 deg., for the purpose of supporting, in photo-macrographic work, the source of light, condensing lenses, light-filters, etc.

A small table, adjustable in height by rack and pinion movement, carries the specimen O (Fig. 7); its top plate has various levelling movements. Macrographs can thus be taken in various ways and by means of different methods of illumination.

Three different methods that can be successfully used, depending often on the weight and nature of the specimen, are shown in Fig. 8. A mirror provided in the arrangement, as shown in Fig. 7, permits sufficiently strong illumination of the specimen O to obtain a brilliant image on the ground glasses of the camera. The macro-attachments can be used for magnifications from 1 to 50, and for reductions from the size of the specimen.

Whilst the above may seem a little abstruse for foundrymen, it is a subject which is coming more and more to the front. Microscopes will be used in the future for controlling the size and distribution of graphite plates, which are synonymous with the strength and wearing properties of cast iron.

Belts for Pattern Shop Machines.

By J. Drinkwater.

The question as to whether the direct drive or the belt drive is the most satisfactory for high-speed woodworking machines is a contentious one. It is admitted, however, that some new pattern shops are installed with motors for each machine. Many experienced men are of opinion that the electric drive is too positive for woodworking machines. Be that as it may, engineers are decidedly reluctant in making changes in the patternshop involving cost. Thus, many of the machines in use in patternshops to-day do not facilitate output as they should do, because they are only fit for the scrap-heap.

It is not to be expected in shops where obsolete machines are used that much attention should be given to the belts. It is very seldom that a belt is renewed. Old belts are frequently introduced, and they keep breaking. Further, it is seldom that proper care is given to use a proper dressing. No matter of what material the belt is made, resin is fed on to it when it begins to slip. The question of correct tension is seldom considered. Belts for woodworking machines are always run at a high speed, and with high-speed belts more attention is needed, because they keep slipping at the fasteners. It is very important that the pulleys should be in proper alignment, because, if bad, it not only causes unsatisfactory working, but also shortens the life of the belts.

Some engineers do not think cotton or leather belts are suitable for high-speed drives at all, because they are subject to weather and temperature fluctuations. Certain it is that they do not retain their natural properties. One writer in a woodworking journal some time ago challenged any high-speed woodworking machine operator to test his spindle speed and his main drive speed, then to compare this with calculated speeds as found by pulley diameters, and affirmed that a discrepancy would be found varying from 20 per cent. to as high as 40 per cent., which means a very considerable loss in output.

Is rubber satisfactory for woodworking machines? Evidence seems to bear out the contention that it is. Rubber is used where the belt is exposed to the action of steam or the weather, because it does not absorb moisture or stretch, as does leather under similar conditions. In this respect it is the most satisfactory power-transmitting medium. It has also a higher co-efficient of friction between the driving and the pulley face.

For some reason or other it may be admitted that the rubber belt is seldom seen in patternshops or other woodworking shops. An important point in favour of the rubber belt is that it does not need any adjusting or shortening after it has been in use for a short time, and it does not warp.

A very reasonable, if minor, argument against belt transmission in patternshops is the inconvenience caused by running belts when long boards are being machined. The conditions are very different from those in the metal machine shops. Usually, the timber is brought in from the wood shed in sixteen-foot lengths, and if not cross cut to short lengths it is faced on the surfacing machine. It has then to be moved to the thicknessing machine, after which, in all probability, it is bandsawn to various shapes. This involves much handling, and as the machines, from space limitation reasons, are close together, considerable care has to be exercised to prevent knocking belts off pulleys. When machining timber, it is necessary for the workman to keep walking round the machine and belts, even if those on the floor level are guarded. The writer was in a patternshop recently in which no belts were to be seen, although all the machines were belt-driven. The main shaft, the counter shafts, and the belts were under the floor level. Channels were formed in the floor, over which removable flooring was fitted, and in those channels the shafting run. To change to under-floor from overhead shafting would involve considerable expense, but it is an excellent idea in laying out new patternshops. Both for lubrication purposes and for repairs, whether to shafting or belts, it is very convenient, as no belt-guards are required, and the shop is both quieter and cleaner than when the shafting is overhead.

An Investigation on the Factors Influencing the Grain and Bond in Moulding Sands.

By C. W. H. Holmes, B.Met. (Birtley, Durham).

INTRODUCTION.

This investigation was undertaken with a view to estimating quantitatively the effect upon the essential properties of the sand of the various processes to which moulding sands are subjected. The essential properties that fall within the scope of this research are: (*a*) the strength of the bond; and (*b*) the ratio of the various mechanical grades, which is the determinant of the venting properties in this research.

Whilst refractoriness is undoubtedly a factor of the greatest importance, even in sands for grey-iron castings, it is obviously so slightly affected by the method of preparation, or any of the conditions here investigated, that it is not discussed in this research.

In foundries where there is no technical control, sand is treated in either of the following ways, depending upon economic conditions, with a view to maintaining a workable bond in the sand.

(*a*) In districts where a good supply of well-bonded moulding sand is available, the old sand is strengthened by means of an addition of from 10 per cent. to 50 per cent. of new moulding sand.

(*b*) In those areas where good moulding sands are expensive, owing to their distance from the foundry, it is usually the custom to replace the burnt-out bond by means of additions of 5 per cent. to 25 per cent. of "loam"; that is, a fine-grained sand having a high clay content and usually containing much silt.

Mechanical mixing is resorted to in the larger foundries in many cases; but in others, especially where "loam" is used, the mixing is done by hand.

Mechanical mixing may be effected by the following means, placed in order of general usefulness: (1) Pug mills and edge runners (pan mills); (2) disintegrators; (3) paddle mixers; and (4) mechanical riddles.

In foundries where technical control is in operation, consignments of moulding sand are usually subjected to bulk chemical analysis in which the content of iron and alumina are frequently reported together and the alkalies are estimated by difference. Such an analysis yields very little useful information as to how the sand will behave under foundry conditions.

Mechanical grading, when carried out, does not usually involve preliminary deflocculation. Thirty, sixty, and ninety mesh sieves are used; not only is this test incomplete, but the size of particle passing the various sieves depends so much upon the gauge of wire with which the sieve is made, that results are not comparable.

The thanks of the foundry industry are due to Professor Boswell in this country, and to Moldenke, Outerbridge, Lane, Hanley, Simmonds, and others in America for having introduced greater refinement into the testing of moulding sands.

Description of Apparatus.

The mechanical tests were carried out on a machine specially constructed for the purpose with a view to applying small loads, of the order of a few hundred grammes, with an entire absence of shock, and at a definite rate in grammes per sec. The machine consists of a beam 12 in. long, resting in its centre upon steel knife edges, and having similar knife edges at either end which work in hardened steel shackles. From one shackle is suspended a vessel capable of holding 2 litres of water; from the other an arrangement, as shown in Fig. 1, is suspended. This consists of two triangular pieces of mild steel, *a a*, connecting the two side pieces, *b b*, to the shackle. The side pieces support either the breaking bar *d* in the transverse test, or a flat plate in the compression test; and the tray *c*, which carries weights to balance, approximately, the weight of water on the opposite arm. The position of the transverse test-bar is shown at T (Fig. 1).

For the transverse-test, two square bars are set in a wooden frame, parallel to the breaking bar and equidistant from it, having their centres 4 in. apart; in making compression tests a flat plate is laid over these bars and the piece is crushed between this plate and another plate fixed between the side pieces in place of the transverse breaking bar. Sufficient water is run into the vessel and the test-piece is placed in position.

Water is now syphoned gently out of the vessel until the beam is floating. A measuring cylinder is then placed under the syphon, and water is allowed to run from the vessel to the cylinder by means of a spring clip until the test-piece fails; the spring-clip is immediately shut off and the volume of water in the measuring cylinder gives directly the breaking stress on the bar in grammes.

The transverse bars are rammed up in a hard-wood core-box with loose sides and loose recessed ends 6 in. × 1½ in. × 1 in., and compressed by means of a wooden top piece having a projection 6 in. × ½ in. × 1 in. to the final size 6 in. × 1 in. × 1 in. The compression pieces are made in a brass boss 1½ in. high, having a ⅝-in. round vessel to overbalance the weights on the tray *c*, hole in the centre, and are compressed by means

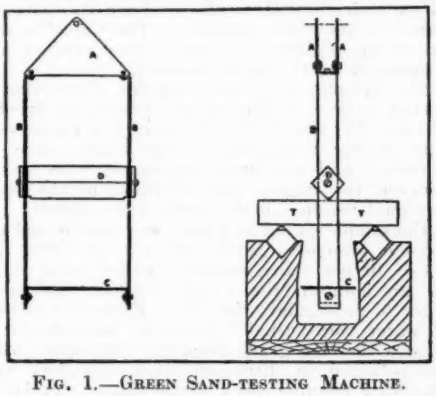


FIG. 1.—GREEN SAND-TESTING MACHINE.

of a small screw press and a ⅝-in. plunger to 1 in. high × ⅝-in. dia. They are then readily pushed from the boss.

(*b*) Mechanical grading was effected by means of a rotary shaking machine for deflocculating the sample, a Crook's elutriator, and a set of metric copper sieves with punched holes as prescribed by the Institute of Mining and Metallurgy. The elutriator is of the standard Crook type and dimensions for separating the sand grade, 1 mm. to 0.1 mm.; silt grade, 0.1 mm. to 0.01 mm.; and clay grade, less than 0.01 mm. An additional jet is used for separating the fine and coarse silt, dividing at 0.05 mm. The following refinements have been found essential in work where considerable accuracy is required.

The water, during cold weather, is passed through a glass coil in a bath of warm water, and then through a bottle containing a thermometer, so that all tests may be made using water at 15 deg. C. The sand-grade tube is clamped rigidly in an absolutely vertical position to prevent the coarse silt sliding down and being estimated as sand grade. The rubber tube connecting the constant pressure head and the sand-grade tube has, with the exception of 2 in. of rubber, been replaced by glass. This was done to avoid the errors caused by pieces of flocculent material being washed off the inside of the rubber and causing trouble in the elutriator; also, should the water pressure fail during a test, sand falls back into the rubber tube, sticks to this degraded surface, and is lost so far as the test is concerned.

For the bond adsorption test a rotary shaking

machine has been made. It consists of a wooden disc, 1 in. thick and 1 ft. 3 in. dia. mounted on a central spindle, and worked by a friction drive direct from the shaft of a ½-h.p. motor. The rotating speed is 50 rev. per min., and the machine is so arranged that one, two, or three bottles may be rotated at once without unbalancing the disc.

The 6-ft. mill used for milling the sand is an edge runner of the usual type and runs at 25 revs. per min. One of the rolls, which weigh 6 cwts., is plain and the other toothed; two distributor plates are fitted to bring the sand under the rollers. The disintegrator is of the horizontal type, the disc 24 in. dia., and the speed 750 revs. per min.

Methods Employed.

After many experiments in ramming up test-bars of sand the most consistent results were obtained by tempering the sand to a moisture content of 7.5 per cent. and ramming up a definite weight of sand by means of the following standardised series of operations.

For the transverse test, 180 grs. of sand were taken; the sand was filled lightly into the assembled core-box until level with the top and pressed down by ten light strokes with a spatula handle. The remainder of the sand was filled in and the process repeated. The top was then placed in position, pressed down by hand, and driven home by ten strokes of a hand hammer.

The compression pieces were made by compressing 8 grs. of sand to the required volume in the mould by means of a screw press.

Stronger bars than those used in these tests can be made by increasing the weight of sand per unit volume of the test-bars; they have not, however, given such reliable results as have the bars prepared in the above manner. The use of a small pneumatic squeezer is under consideration as a refinement of the above method.

The samples were prepared for elutriation by taking 10 grs. of the sample, previously dried at 110 deg. C., and passing it through a 1-mm. sieve. Any residue remaining on the 1-mm. sieve was examined and any grain aggregates were crushed between the fingers and returned to the sieve; any final residue on this sieve was weighed.

The sample sieved to 1-mm. was transferred to a 500 c.c. stoppered bottle, 250 c.c. of water, and 5 c.c. 10 per cent. ammonia added, and shaken for an hour on the rotary shaking machine in order to deflocculate the clay. Eight to ten litres of water were usually found to be sufficient to remove the clay grade from the elutriator, which was collected in litre-graduated cylinders (this afforded a running check on the rate of elutriation, which was kept steady at 100 c.c. in ninety seconds), and allowed to settle out in Winchester bottles. Five minutes before the end of the test, the clip between the sand and the silt vessels was partially closed to avoid the coarse silt running back into the sand vessel. In the case of a sand such as Mansfield, where a large percentage of the grains vary between 0.15 mm. and 0.08 mm., this precaution is very necessary.

The silt grade was elutriated into two grades, 0.10 mm. to 0.05 mm. and 0.05 mm. to 0.01 mm. after removal of the sand grade from the lower vessel, by means of a different head and jet; working at 27.5 c.c. per 100 secs. The bulk of the water was decanted from all grades, which was subsequently dried at 110 deg. C. and weighed. The sand grade was then divided on the sieves and the fractions weighed.

The bond adsorption test was carried out after the method of Hanley and Simmonds. From 10 to 20 grs. of sand, depending on the bond, were weighed into a 500-c.c. stoppered bottle and rotated for an hour with 250 c.c. of distilled water and 5 c.c. of 10 per cent. ammonia. A solution of acetic acid, of such strength that 5 c.c. rather more than neutralised the ammonia, were added, and sufficient crystal violet dye (to give at least 0.004 grs. excess after adsorption) dissolved in 100 c.c. of distilled water. Any dye remaining in the beaker was rinsed into the bottle with 40 c.c. of water (making a total volume of 400 c.c.) and the bottle shaken for a further two hours. After standing for some hours, 100 c.c. of the clear gradually raised to 60 deg. C. After the whole of acid and 25 c.c. of water added, and the excess of dye was removed by introducing a 5-gr. hank of mordanted cotton yarn, the temperature being gradually raised to 60 deg. C. After the whole of the dye had been removed from the solution, the yarn was withdrawn, washed, and dried at 75 deg. C. This hank was then compared with a series of similar ones, on each of which a standard weight of dye had been deposited. From this the weight of dye adsorbed by the bond of the sand is calculated.

The analyses were made on 0.5 gr. of the finely ground sample. Loss on ignition was determined, and a fusion effected by heating the residue with 5 grs. of fusion mixture.

Silica was separated by two extractions; the yield of silica obtained on taking the filtrate from the first residue to dryness being usually of the order of 0.6 per cent.

Iron, alumina, titanium, and phosphorus were separated by precipitation on ashless-pulp fibres with ammonia. From the weighed residue, iron was estimated by stannous chloride and di-chromate and the alumina as phosphate. Lime was precipitated as oxalate and estimated volumetrically with permanganate. Magnesia was weighed as the pyro-phosphate. The alkalies were determined by the Lawrence-Smith method and separated by perchloric acid.

The casting tests were made in the following manner: Three circular moulding boxes, each 4 in. deep and 1 ft. 6 in. dia., were taken. One of them was rammed up with floor sand and dried; over this was placed a disc of 30-mesh iron gauze 18 in. dia., having a 3½-in. hole in the centre.

A second box was placed upon the gauze and rammed up with the sand under investigation round a cylindrical pattern 8 ft. long, 3 in. dia., placed in the centre of the box. A good joint having been made, straight wires of tin, lead, zinc, aluminium, and silver, each exactly 6 in long, were laid radially along the joint and touching the pattern, filling an angle of 60 deg. The third box was now put on, rammed up, the position of the wires marked on the box, and the metal was poured into the green-sand mould. The object of the dry-sand drag and the wire gauze covering was to provide a solid foundation for the mould without risk of contamination of the sand whilst on the foundry floor or whilst taking the samples of sand from the mould after casting.

The samples of sand were taken, after the mould had cooled down, as follows: The sand up to ½ in. from the face of the casting was isolated by pressing down through the sand a cylinder of tinned sheet. About 90 deg. of the cylinder was cut away and ½ in. of edge turned in at each side, so as not to cut the wires. The samples at 1, 2, and 4 in. from the face of the mould were taken by means of a tinned sheet tube 1 in. dia.

When all tube samples were taken and transferred to their respective tins the casting and sheet metal casing were removed, the sand transferred to its container, the wires carefully dug out, and the length over which they had melted was measured.

(To be continued.)

Malleable Iron Melting by Powdered Coal.

When powdered coal was first applied to malleable furnaces, considerable difficulty was experienced in bringing the bath to the desired temperature without large oxidation losses. To overcome this difficulty the Grindle Fuel Equipment Company, of Harvey, Ill., U.S.A., have designed a furnace having burners entering directly into the chamber which contains the hearth and in such a manner as to cause the flame to create a circulating motion to the bath, so that all parts of the bath will be quickly brought to a high temperature. This construction was first put into operation in 1919, and has since then been employed with much success by some of the largest malleable foundries in the United States. The system is covered by Letters Patent.

Institution of British Foundrymen.

NEWCASTLE BRANCH.

Discussion on Mr. F. Darley's Paper on the Production of Steel Castings.

THE BRANCH-PRESIDENT (Mr. Paterson), in opening the discussion, said that steel founding was not a particularly common practice in this neighbourhood, and when we see the various designs for casting the intricate and dangerous castings which Messrs. Thos. Firth & Sons have successfully turned out, one cannot be surprised at the high name they have attained.

MR. WALLIS said that if we had reached the stage in which castings could be made of stainless steel many troubles would disappear. In the moulds shown by Mr. Darley he saw no signs of chills used to get uniform cooling, and he would like to know if one could use that practice in steel castings.

MR. DARLEY, in reply, said he quite believed that in a short time we would be able to make stainless steel castings, and that he knew for a fact several firms had made propellers in stainless steel. With regard to chills they used to use them, but not now. If a chill was put against a steel casting, unless there were chills all round, it would be liable to cause pulls and cracks on the face where the chill joins the sand.

MR. FRIER asked what sort of chaplets were used for steel castings in green sand, and if so whether they would give the same trouble as in the iron foundry. Further, he would like to know what was the maximum weight of steel that could be cast green.

MR. DARLEY replied that if it was a light job ordinary tinned chaplets were used; for heavy work turned steel barrel shape, he considered, were the best, but in stainless castings they must be of stainless steel.

Composition and Fluidity.

MR. SMALLEY asked if the rise of fluidity was an effect of temperature rather than one of composition, as suggested by Mr. Darley.

MR. DARLEY said that they had had a lot of trouble, which they traced to the analysis. When this was examined they were told that there was nothing wrong with the steel. He (the speaker) thought that it was on account of the steel not being sufficiently fluid, but he was ridiculed, and told that the steel could not be too pure. He had increased the silicon to 0.4 per cent., the carbon to 0.22 per cent., the manganese to 0.7 per cent., and the phosphorus to not exceeding 0.06 per cent., but where the phosphorus, sulphur and silicon were low the castings were full of blow- or gas-holes on the bottom side as cast.

MR. H. J. YOUNG agreed with Mr. Darley on the question of impurity and fluidity. He felt that many people were too inclined to term everything as an impurity, and believed steel could be too pure the same as cast iron is sometimes made too pure by taking out the things that make it cast iron. He thought it possible that by having material too pure it would give a bad casting. He had seen many faulty castings in steel, and hoped some of the local steel founders would not be frightened to come to those meetings and talk over their troubles. He thought that Germany made better castings than us, simply because they tried harder. If only steel founders would attend meetings, read papers, and discuss difficulties British steel castings would improve as a result.

Manganese Steel.

MR. FLACK asked why it was that some manganese steel wheels from 30 lbs. to 50 lbs., containing 30 per cent. manganese, broke into pieces after annealing and plunging into cold water.

MR. DARLEY said he thought that people who ordered manganese steel castings for wheels were seeking trouble. In intricate castings, such as wheels, he was not surprised at some breaking, it all depended upon the analysis of the steel being correct, which should be about 15 per cent. manganese.

MR. BROWN asked with regard to the ingot moulds cast with headers whether the same thing is done with large steel castings. Working in cast iron one gets contraction difficulties. He also asked if the section of ingot shown on the screen was that of a normal one.

MR. DARLEY replied that he had explained that it was an extraordinary one, and that the majority were not piped above 6 in. Similar headers might be possible in steel castings, but he saw no advantage for cast-iron castings as the header box served the purpose.

MR. PAULIN said he admired the castings illustrated, but possibly the usual flaws were lost by reproduction. He was interested in the ingot casting, and presumed that in order to reduce the piping effect it was preheated. He remarked that in some of the loco. wheel centres the boss looked extraordinarily heavy compared with the arms, and asked if they could have used a collapsible cast-iron core in order to hurry up the cooling. He wished to know whether stainless steel was ever used for chaplets. Could ingots be cast in sand moulds?

Locomotive Wheel Centres.

MR. DARLEY said that casting ingots in sand moulds was not a paying proposition. If one watched a row of ingots after casting one could follow the process of the contraction, and immediately the metal is cast it begins to sink. The ingots made nowadays have not more than 5 in. or 6 in. pipe. He remembered about 30 years ago how firms making loco. wheel centres used to have to knock the mould to pieces as soon as they were cast to get the castings out to relieve contraction, but this was overcome by using different material for the boss.

Annealing Steel Castings.

MR. CARMICHAEL asked whether the annealing stove could not be dispensed with. He said he knew of some satisfactory castings made in Germany about 12 years ago which were not annealed. He wanted to know if it was possible to have castings of stainless steel made without the use of the annealing stove, or if it was just as important with stainless steel to incur the extra cost and time of annealing.

MR. DARLEY answered that it was possible to a certain extent, but the casting structure had to be broken down. They could get the same test within a ton, and a very small percentage of elongation. He quite believed that some people did not anneal light steel castings, it was not really necessary, but his firm annealed everything they turned out.

MR. GRESTY asked whether the casting temperature was controlled, or did they have to take the metal as the furnace gave it to them.

MR. DARLEY replied that 1,600 to 1,700 deg. was the proper casting temperature for mild steel. The milder the steel the hotter it should be, and the hotter the steel the greater the contraction. He had an experience of a large spur wheel cast in two halves, both cast in the same heat, and when measured one would be found to be ½ in. smaller than the other, and it is worthy of note that invariably the casting cast first is the smaller, because the higher the temperature the greater the contraction.

MR. MATHEWS asked the thickness of the steel blades in the turbine casting exhibited.

MR. DARLEY replied that the thickness of the blades was 3-16 in. He said that they had made some experiments with the blades made in stainless steel, and that they stood it better than mild steel.

DISCUSSION AT SHEFFIELD.

THE CHAIRMAN, Mr. John Watson, said they had listened with great interest to Mr. Darley's Paper, which had been distinctly descriptive, and, he might say, that there were very few points brought out that would make them have an acrimonious discussion. A brief general discussion followed, during which MR. HYDE said that one of the most interesting things he saw in Belgium was a moulder working practically without a pattern, but he was given a blue print. It was a tremendous eye-opener to him (Mr. Hyde). He was pleased to see that they were getting halfway to it even in that conservative city of Sheffield.

He would like to know whether the lecturer found that contractions were likely to vary. Sometimes they found that contractions on the Monday were different to what they were on the previous Thursday.

MR. BRADLEY congratulated Mr. Darley upon his Paper, and said the interesting part to him was the number of moulds they made in the floor in preference to boxes. He asked how Mr. Darley brought into circle the spur-wheel rim that was $\frac{3}{8}$ in. out. Could he give them any idea of the weight of head they put on the various sized castings?

THE CHAIRMAN said that the Belgians, in order to help contraction, sank holes about 3 ft. deep, 3 in. at the side of the mould, right round the castings, and almost before the metal was set they filled these holes with water. It was a method of helping contraction he had never seen practised in Sheffield.

MR. DARLEY, replying to Mr. Watson, said contraction was generally on the inside. Then with regard to the wheel, it was $\frac{3}{8}$ in. only. It was a difficult problem to get an oval thing round. He got a 150-ton jack, put it inside across the narrow diameter, and forced it out until they got it true. He put a strong stay on each side of the jack, took the jack out, put the casting into the furnace, and heated it up to about 650 deg. C. and it came out sound. With regard to feeding heads most of the big castings generally ran out about one-third. Contraction was a very uncertain quantity, and depended mainly upon the analysis and temperature of the steel. There was nothing impossible in connection with steel castings if they knew how to handle them.

THE CHAIRMAN said they had been much pleased and instructed by Mr. Darley's lecture, and he had pleasure in proposing a vote of thanks should be accorded to him. This MR. HYDE seconded.

Aluminium Alloy Pistons.

By F. A. LIVERMORE.

Since the introduction of aluminium alloy pistons, some nine years ago, the two chief difficulties has been the development of a suitable alloy and a satisfactory design. The use of aluminium pistons has been the subject of diverse controversy, and in considering their adoption the following difficulties arise :—(1) The strength of the material must be such that it will resist shocks as occur in internal combustion engines, especially momentary increments of pressure arising from pre-ignition. (2) The material must have a high thermal conductivity since the heat is intermittently applied only to the head of the piston. (3) The coefficient of thermal expansion must be comparable with iron, otherwise the increase in clearance to compensate for a greater coefficient of expansion would cause piston slap until the engine warmed up. (4) The alloy must be capable of resisting the wear of the piston rings and (5) the alloy must be readily compounded and worked.

Some tests made by Dr. A. H. Gibson, suggested that the temperature to which pistons are exposed in service is in the neighbourhood of 250 deg. C., although from pure metallurgical evidence of the writer, prepared specimens of piston alloys have shown a marked change in internal structure, which must have occurred at temperatures well above 250 deg. C. On the other hand it is advocated by some metallurgists that in high-efficiency internal combustion engines the head of the piston attains a temperature close to the aluminium-copper eutectic (well over 500 deg. C.) and piston failure is only avoided by efficient lubrication. It seems most probable from the results obtained from the use of aluminium pistons that the attainment of these temperatures must be exceptional, and the temperature to which pistons are exposed during the working stroke is in the neighbourhood of 250 deg. C.

However, the thermal conditions under which the casting is required to work, is very different to the working at ordinary temperatures. Most alloys of aluminium decrease in tensile strength proportionately with rise in temperature. Consequently, in considering the adoption of a particular alloy, the ultimate strength at temperatures between 200 deg. and 400 deg. C., subject to such alternating stresses as would occur in the cylinder, must be ascertained. A fair amount of experimenting has been done in this direction, and some useful data established.

The zinc series of alloys show rapid deterioration with rise in temperature, and are unsuccessful.

The plain copper-aluminium alloy of 7 to 12 per cent. of copper have answered fairly well in practice, but around the temperature of 250 deg. C. in varying degrees, the alloys show a falling away of tensile strength with rise of temperature and a marked decline in the thermal conductivity, which is a disadvantage, since with a high thermal conductivity piston, a greater compression ratio can be used without fear of pre-ignition.

The addition of manganese up to 1 per cent., to the copper series of aluminium alloys, maintains the tensile strength at a high temperature, but unfortunately lowers the thermal conductivity, and the piston works at a higher heat, which is not desirable.

The National Physical Laboratory advocates the suitability for pistons of an aluminium alloy containing 4 per cent. of copper, 2 per cent. of nickel, 1.5 per cent. of manganese, which in the form of 1-in. dia. chill-cast bars, gave an ultimate stress at 250 deg. C. of approximately 12 tons per sq. in., compared with 7 tons for a 12 per cent. copper alloy. This alloy was largely employed for piston work a few years back.

Comparing the thermal conductivity of an aluminium alloy piston with cast iron, it is in the ratio of approximately 4 to 1, or, the power of heat conducting of the alloy is four times as great as the cast iron. This allows for increased compression, considerably minimises pre-ignition, decreases carbonisation and leads to a considerable fuel economy. Dr. A. H. Gibson in a series of experiments found that the aluminium piston yielded 6 per cent. greater horse-power with 5 per cent. less fuel, an increase in thermodynamic efficiency of 12 per cent., and the reduction of inertia forces to such an extent that vibration is practically eliminated and much high speed can be attained.

However, some cases of burnt aluminium pistons have come to light, and show the upper side of the piston-head to be pitted similar to a sand-eaten casting. No doubt the cause from the engineering standpoint has been the failure of the lubrication system, or through a badly designed piston. From the metallurgical standpoint, the failure appears to be due to the fusion and migration of the copper-aluminium eutectic, with the ultimate disintegration of the whole metal. It is necessary when casting piston alloys, to keep the temperature as low as possible to avoid the existence of large connected masses of copper-aluminium eutectic. A well-designed piston should have a considerable body of metal in the head (up to $\frac{1}{4}$ in.) and behind the piston rings, so as to ensure adequate cooling, but on the other hand, the increase in clearance, rendered necessary by the greater coefficient of expansion is apt to cause a certain amount of noise and looseness (piston slap). It has been found, experimentally, that the clearance should be 50 per cent. greater than with a cast-iron piston. No appreciable wear, either to the body of the piston or in the ring grooves, takes place; the supposed so-called "growth" of aluminium alloy piston has had careful experiments, and has been found to be practically negligible in comparison with the thermal expansion. From experiments by the National Physical Laboratory, the permanent growth amounts only to 0.0004 in., which can be completely eliminated by previous annealing, and so it seems that growth is not a factor for serious consideration.

The question of heat-treatment of the alloy pistons is very necessary to obtain the best results. The cast pistons are subjected to a temperature of about 380 deg. C. for at least 6 hours, though it is preferable to prolong this annealing to one day, in order to bring the copper-aliminium compound ($CuAl_2$) into solid solution. This heat-treatment gives homogeneity to the structure and also neutralises casting strains; it greatly improves the mechanical properties of the alloy, particularly when working at the higher temperatures.

Trade Talk.

THE GOVANHILL IRONWORKS, Glasgow, are about to resume work after having been closed down for a period.

BERTRAMS, LIMITED, St. Katherine's Works, Sciennes, Edinburgh, propose to carry out extensions at their Westfield Foundry.

WHITEHOUSE BROS., LIMITED, Bridgetown, Cannock, have taken over the business of William Gilpin, Senr., & Company, Limited, axle and edge tool manufacturers, of Cannock.

NEW CLASSES in elementary metallurgy for foundrymen have been approved by the Higher Education Committee of the Crewe Town Council during the coming winter session.

LEDWARD & BECKETT, LIMITED, condenser and pump manufacturers, have removed from King's House, King Street, London, E.C.2, to Parliament Mansions, Victoria Street, Westminster.

BOWES SCOTT & WESTERN, LIMITED, mining machinery manufacturers, have removed from King's House, King Street, London, E.C.2, to Parliament Mansions, Victoria Street, Westminster.

MELDRUMS, LIMITED, Timperley, near Manchester, received sixteen orders for their forced draught furnaces last month, including 1 pumping station and 4 collieries (repeat). Orders for 3 destructors were also secured.

A CIRCULAR to the shareholders of Bolckow, Vaughan & Company, Limited, of Middlesbrough, states that the directors have decided to postpone the ordinary general meeting of the company to a date later in the year than is customary.

IRONCLAD SWITCHGEAR COMPANY, LIMITED, have removed their London office to 23, Queen Anne's Gate, Westminster, London, S.W.1, which will deal with inquiries emanating from South Wales, Midlands, East Coast, Southern Counties and Overseas.

IN the vestibule of the offices of Babcock & Wilcox, Limited, Moorpark, Renfrew, a memorial has been unveiled to the memory of the employés who fell in the war. The ceremony was performed by Sir John Dewrance, chairman of the company, whose gift the memorial was.

MR. PHILIP CHAPMAN, under the style of Philip Chapman & Company, at 5, Copthall Buildings, Copthall Avenue, London, E.C.2, has re-established himself in business as an iron and steel export merchant, a business which, prior to the war, he carried on at 36, Victoria Street, London, S.W.

CLAIMING to be the oldest man in the country to have followed up the duties of a moulder for a period of 71 years, P. Worton, a native of Sedgley, near Dudley, is still in the employ of the Cannon Iron-foundries, Limited, Deepfields, near Bilston, whose service he entered when only nine years of age. He is now 80 years of age, and is still following his employment as a moulder.

THE WHITEHAVEN HEMATITE IRON AND STEEL COMPANY, LIMITED, have restarted one of their furnaces at Cleator Moor. These works were stopped about two months ago. The iron-ore mines belonging to the same company are also being restarted at once. These will include the Town Head Mines, Egremont, Parkside Mines, Frizington, and Fletcher's High House Mines, Frizington.

J. G. KINCAID & CO., Greenock, who hold a sub-licence from Harland & Wolff for the construction of Diesel engines on the Burmeister & Wain system, have received an order for a set of six-cylinder engines of this type. The engines are to be capable of developing 1,350 b.h.p. Another similar set, capable of developing 1,900 b.h.p., has been ordered by a Spanish firm for early delivery.

THE ASCERTAINMENT FOR AUGUST under the sliding scale in operation in Cumberland and North Lancashire shows that during the month the price of West Coast ordinary hematite pig-iron fell from 98s. 8d. to 91s. 3d. per ton. Blast furnacemen's wages accordingly drop 26½ per cent. above the standard, but an agreement between the ironmasters and men stipulates that they shall not descend below the minimum of 35½ per cent. above the standard.

THE NATIONAL GAS ENGINE COMPANY, LIMITED, Ashton-under-Lyne, point out that they will be pleased to render assistance during the coming winter to lecturers wishing to deal with the subject of internal combustion engine and suction gas plants. They have a selection of lantern slides, views of works, installations, sectional views, etc., which are for loan free of charge. Assistance in the preparation of lectures as far as their own manufactures are concerned is also given.

A SERIES of meetings of the men engaged in the steel melting and rolling trades was recently held on Tees-side to consider the proposal of the employers that the war-time arrangement of the three shift system should give place to the old working system of two shifts of twelve hours each. Another change already brought about is that of one first-hand having charge of two furnaces instead of the usual working of a "first hand" at each furnace. The grading of the other men employed on a furnace is also under review. The meetings that have been held, however, have been in the nature of joint conferences of all the men affected by the proposal which had been referred to the men by the officials of their association. The decision of the meetings held was not to accede to the proposal.

MR. W. E. HIGHFIELD, president of the National Association of Supervising Electricians, speaking in London, said the electric industry, in common with all other industries, was in a position of great difficulty. If they were to regain their lost position in the world's markets it could only be done by regaining their reputation for making high-class apparatus and being satisfied with a reasonable profit. The nation now appeared to be setting seriously to work. For the year 1921 the majority of engineering firms probably did not reach more than one quarter of the output necessary to pay a return on capital. For the year 1922 that output had probably increased to one-third or one-half. Were they to go through 1923 without any further trade disturbances, their industry should reach an output that would pay a return. If a sense of security prevailed the flow of work would increase, and the recovery and ultimate prosperity of the industry would be assured.

British Electric Furnace Prospects.

A distinct movement is on foot for the greater application of the electric furnace to the non-ferrous industry, where, although of more recent application, it is already relatively much more important in the world's production than electric steel furnaces. Should the price of current be seriously lowered in the near future, a large field would open for the extension of electric heating for heat treatment, mould and core drying. Of all metallurgical considerations, none can show greater advantages than is bestowed by a well-controlled heat-treating furnace. Its possibilities are great, as its temperature variations are confined within small limits.

Iron and Steel Output in August.

The National Federation of Iron and Steel Manufacturers report that the production of pig-iron in August amounted to 411,700 tons, or 12,600 tons more than in July. The average monthly output in 1913 was 855,000 tons. The August output included 120,200 tons of hematite, 137,400 tons of basic, 102,200 tons of foundry, and 22,900 tons of forge.

The production of steel ingots and castings amounted to 520,800 tons, or 47,700 tons more than in July, but still only 69 per cent. of the average monthly production in 1920, and some 118,000 tons below the average monthly output in 1913.

Chemical Research.—Summarising his conclusions at the close of his address on "The Organisation of Research" before Section B. (Chemistry) of the British Association at Hull, Principal J. C. Irvine, D.Sc., F.R.S., remarked that the first and most important condition is that in each institution there should be a Board or Standing Committee entrusted with the supervision of research. The functions of such a body would be widely varied, and would include:—(1) The allocation of money voted specifically from university or college funds for research expenses. (2) The power to recommend additions to the teaching staff in departments actively engaged in research. (3) The recommendation of promotions on the basis of research achievement. (4) The supervision of regulations governing higher degrees. Among the more specific problems which confront this Board are the following:—(1) The creation of research libraries where reference works can be consulted immediately. (2) The provision of publication grants, so that where no periodical literature is available the work will not remain buried or obscure. (3) The allocation of travelling grants to enable workers to visit libraries, to inspect manufacturing processes, and to attend meetings of the scientific societies. The author was convinced that it was a mistake for a governing body to call for an annual list of publications from research laboratories. Nothing could be more injurious to the true atmosphere of research than the feeling of pressure that papers must be published or the Department would be discredited.

Company News.

Presswell Engineering & Welder Company, Limited, Bradford.—Capital £2,000. Directors: W. C. Priestley and H. D. Blackhurst.

Cunliffe Brothers, Limited, 33, Castle Gate, Nottingham.—Capital £1,000. Engineers, founders, etc. Director: J. W. Cunliffe.

C.R.L., Limited, 604, Fulham Road, London, S.W.—Capital £3,150 in 3,000 "A" ordinary of £1 and 3,000 "B" ordinary shares of 1s. Engineers.

Birchfield Foundry Company, Limited, Chain Walk, Birchfield, Birmingham.—Capital £3,000 in £1 shares (1,000 ordinary and 2,000 preference). Iron, steel, brass and metal founders.

W. H. Baker, Limited, Clayton Street Brass Foundry, Clayton Street, Wigan.—Capital £20,000 in £1 shares (10,000 6 per cent. cumulative preference and 10,000 ordinary). Brass founders.

British Aluminium Company, Limited.—Ordinary dividend, 5 per cent. per annum, less tax, for six months ended June 30; preference dividend, 6 per cent. per annum, less tax, for same period.

Badman Brothers, Limited, Beaufort Street, Cricklewell, Brecon.—Capital £10,000 in £1 shares. Engineers. Directors: C. H. Badman, W. F. Badman, J. A. Badman, E. G. Badman, and H. G. Inray.

Singleton & Priestman, Limited.—Capital £5,000. Edge tool manufacturers and merchants, etc. Directors: E. Priestman (permanent director and chairman), W. T. Montford, G. W. Womersley, and Barbara Priestman.

William Beardmore & Company, Limited.—Profits, £127,287; brought forward, £711,909; total, £839,197; interim dividend on preference, £43,200; balance, £795,997; final preference dividend, £43,200; carried forward, £752,797.

Nobel Industries, Limited.—Profit, £809,242; disposable balance, £604,264; brought forward, £757,498; preference dividend paid; ordinary dividend for year, 5 per cent., less tax; investment reserve account, £350,000; carried forward, £463,349.

Parc Engineering Company, Limited, 142, Earlsdon Avenue, North Coventry.—Capital £2,000 in £1 shares, to take over the business of machine tool manufacturers and engineers carried on by Parc, Limited, at Clarence Works, Lockhurst Lane, Coventry, and to adopt an agreement with M. G. Dadley.

Gazette.

REID BROS., ENGINEERS, LIMITED, are being wound up voluntarily, with Mr. H. Ashford, 91/3, Bishopsgate, London, E.C.2, as liquidator.

THE HENDON METAL WORKS, LIMITED, 176, The Broadway, Hendon, Middlesex, are paying a first and final dividend of 6s. 6½d. in the £.

ELECTRICAL INDUSTRIES, LIMITED, 9-10, Pancras Lane, Queen Street, London, E.C., are paying a first and final dividend of 5 1-7d. in the £.

THE PARTNERSHIP heretofore subsisting between Messrs. P. A. W. Parkyn and G. I. Murray, Junr., Vulcanite Engineering Works, Carrington Field, Stockport, under the style of Murray, Parkyn & Company, has been dissolved.

MESSRS. E. G. R. PARR, W. E. R. Parr, E. H. Parr, A. C. Parr, H. K. R. Sutton, engineering, electrical and general pattern and model makers, etc., 224, Bermondsey Street, London, S.E.1, trading under the style of E. B. Parr & Company, have dissolved partnership.. The business will be carried on in future by Messrs. E. G. R. Parr and W. E. R. Parr.

Personal.

MR. T. EAGLESFIELD, district locomotive superintendent for the Midland Railway Company at Hasland, will retire after 51 years' service on the 19th inst.

THE LATE Mr. W. H. Brittain, J.P., of Storth Oaks, Sheffield, file and tool manufacturer, left estate of the gross value of £49,584, of which £24,336 is net personalty.

SIR JAMES BROWN MARSHALL, chairman of John Samuel White & Company, Limited, from 1906 to 1917 Director of Dockyards at the Admiralty, who died on July 22, left estate of the value of £26,262.

MR. J. T. HARRIS has resigned his position as managing director of Harris Bros., Limited, ship-repairers, engineers, and boilermakers, Swansea. The directors have appointed Mr. J. A. Bonnyman as general manager. Mr. Bonnyman is the son of Mr. James S. Bonnyman, consulting engineer, of Cardiff, and joined the firm of Messrs. Harris Bros. about 18 months ago, having previously been with Smith's Dock Company, Limited, South Shields.

Contracts Open.

Bridgend, September 26.—Supply of iron and lead pipes, pig lead, etc., for the Mid-Glamorgan Water Board. Mr. I. M. Howell, Clerk to the Board.

London, S.E., September 29.—Supply of about 14 tons of solid drawn copper tubing, 1,650 gross of split iron pins, 43,250 wood screws, and 3,019 dozen files. The Director-General, India Store Department, Belvedere Road, Lambeth, London, S.E.1.

London, S.W.1, October 4.—Supply of gas cooking stoves, for the National Gas Council of Great Britain and Ireland. W. J. Smith, secretary, 30, Grosvenor Gardens, London, S.W.1.

London, S.W., October 4.—Supply of 704 axleboxes for wagons, 36,000 fog signals, and rivets, nuts and pins, for the South Indian Railway Company, Limited, 91, Petty France, Westminster, S.W.1. (Fee, 10s., not returnable.)

Sofia, Bulgaria, October 7.—Supply of copper tubes, brass rods and wire, etc., for the Bulgarian Directorate of Railways at Sofia. The Department of Overseas Trade (Room 49), 35, Old Queen Street, London, S.W.1.

Deaths.

MR. RICHARD CRITTALL, managing director of Richard Crittall & Company, Limited, engineers, of 197, Wardour Street, London, W., died recently in his 68th year.

MR. A. J. EVANS, who recently died at Wolverhampton, was proprietor of William Evans, Son & Company, brassfounders and manufacturers of locksmiths' requisites.

MR. WALTER WILSON HERON, a veteran shipbuilder of Blyth, has died suddenly at the age of 85 years. Mr. Heron was one of the founders of the Co-operative Shipbuilding Company.

MR. F. V. JONES, consulting engineer, and a director of Edwin Danks, Limited, engineers, etc., Oldbury, has died at his residence, 80, Reddings Road, Moseley, Birmingham.

MR. JOHN ALEXANDER MACPHERSON, director and secretary of P. & W. Anderson, Limited, the contractors, whose death is announced, apparently fell from the train in which he was travelling from Bideford to London.

MR. HARRY KAYE, whose death is announced at the age of 50, had been a member of the Metal Exchange for many years. Born in London, he had been practically all his life identified with the City, and from an early age was associated with the metal trade in various capacities. In recent years he was buyer for a well-known City firm, relinquishing his post to enter into business for himself as a dealer in non-ferrous metals. He established himself in business over a year ago at 12, Fenchurch Avenue. He was formerly connected with H. Koenigs & Company and H. B. Barnard & Sons.

New French Steel.—M. Chafnard, director of the steel laboratory at Imphy (Nièvre) has recently developed a new kind of "steel," the composition and qualities of which have been communicated to the Académie des Sciences by M. Le Chatelier. Into the composition of the new metal enter 60 per cent. nickel, 12 per cent. chromium, 2 per cent. manganese, and 0.5 per cent. carbon. It is claimed to be rust-proof.

Proposed Association of British Engineering Societies.—The President and Council of the Society of Engineers have issued a circular giving particulars of a conference of Engineering Societies which they are convening for September 29 next, to be held at the Engineers' Club, London, at 3 p.m., for the purpose of considering and, if thought advisable, inaugurating the formation of an Association of British Engineering Societies. Some 21 societies have been invited. The Secretary's address is 17, Victoria Street, Westminster. S.W.1.

Port Statistics.—Statistics issued by the Ministry of Transport relating to the working of the principal ports in the United Kingdom show that the total net registered tonnage of vessels arriving with cargoes or in ballast was 12,735,450 last June, as compared with 6,596,470 in June, 1921. As regards vessels departed with cargoes or in ballast in the coasting and the foreign trades, their tonnage last June was 12,864,881, as against 6,500,494 in June, 1921. The average number of days' working in ten leading ports by vessels engaged in the foreign trade varied last June between 1.78 (Swansea) and 5.78 (London), while the number of days lost in port prior to completion of working during the same month in seven leading ports varied between 0.01 (Manchester) and 0.97 (Cardiff). Sundays and holidays excepted.

IRON AND STEEL MARKETS.

Pig-iron.

Reports from the various centres of the industry confirm generally a continuance of the improvement previously noted in the pig-iron trade, which, although admittedly slow, is leading to a gradual expansion of production. In South Staffordshire conditions in the pig-iron market continue firm, although sellers have not been able to obtain the advances they sought when coke became dearer, and are no longer quoting these advanced rates. At the former quotations, however, they are very firm, and there are no concessions to be obtained. The volume of demand remains fairly constant, with recently a slightly increasing tendency. Midland smelters, however, have been helped considerably by the export demand. Their share of it has been comparatively insignificant, but still helpful. At Glasgow recently the demand from America for pig-iron was inclined to slow down a little. In view of the amount of business put through previously this was not unlooked for, but later the demand has regained its former strength, and a considerable tonnage of Scotch as well as Middlesbrough iron has been sold. In fact, unless for some small quantities held in second hands, there is no No. 3 Scotch or Middlesbrough to be bought till after October. Quotations are therefore very firm. On Tees-side sales to the United States, and also to Canada, are still the dominant feature on the Cleveland iron market. A big cargo of foundry iron to special analysis was placed last week, and substantial sales of No. 3 and also of the lower qualities are reported. Meanwhile the home foundries are getting busier, and recently there has been a brisk demand for iron. The effect of these conditions has been greatly to accentuate the scarcity of Cleveland pig-iron, and particularly, of course, of the standard No. 3 quality. Indeed, there is practically no No. 3 obtainable for prompt delivery, and October is generally the earliest date named. It is not surprising, therefore, that the quotation of No. 3 experienced a sharp advance at last week's market, makers asking as high a figure as 95s. per ton. Export inquiry on the whole is rather better, but conditions on the Continent preclude anything like real activity. Quotations are as follows:—No. 1 and silicious, 97s. 6d.; No. 3 G.M.B., 95s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 85s.; mottled and white about 82s.

In the East Coast hematite trade conditions are still disappointing. There has been, it is true, some little improvement of late, but it has not been sufficient to enable makers to lift to any marked extent the heavy stocks still lying on the ground. Only a few small cargoes have been sold to America, West Coast descriptions, with a lower phosphorus content than mixed numbers, being most in favour. West Coast sales may help the East Coast home trade, but so far this does not appear to have been substantially noticeable. Makers are quoting 90s. for mixed numbers, with 6d. per ton more for No. 1, but this is practically a nominal figure, for it is possible to buy, for substantial lots, at 1s. and even more per ton less. Messrs. Gjers, Mills & Company, Limited, who have for some time been running on a single furnace, have now put a second in blast.

Finished Iron.

The manufacturing branches of the iron trade remain as inactive as reported for some time past, a large proportion of the plant being partly idle, or even entirely unemployed, with, so far, few encouraging signs of returning to normal conditions. Some explanation of the present position of the finished iron trade may be advanced in the fact that costs of production are still relatively much higher than in the pre-war period, although the wage rate calculated on the basis of the selling price of the material is now substantially reduced. Railway transport charges are perhaps the most serious impediment to lowering finished iron prices, the recent revision having been altogether inadequate as a stimulus to a more active demand. In the South Staffordshire market crown bars maintain the firmness recently noted, and are not to be bought at less than about £10 15s. to £11; but there is also to be obtained plenty of iron inferior to the crown quality, but superior to the common bar, which sells at round about £10 12s. 6d. Nut and bolt iron realises about 5s. less. Hopes are entertained of an impending revival in the demand for good crown bars owing to reports of an improvement in the engineering trades. The marked bar houses are fairly well employed, but there is no real vigour of demand at £13 10s. (net, f.o.t. makers' works).

Steel.

At Sheffield recently a much more optimistic feeling was expressed concerning the outlook in the great industry of which that district is the centre, and with gradually reviving confidence market movements have evidenced an activity indicating steady expansion of demand for certain qualities of steel material, both for home and export. Among leading lines for which inquiry is in increasing volume are basic billets, but producers of acid qualities could do with more substantial business than is the case at present. Some of the special steels which Sheffield features are slightly more in demand, and with the Government stocks of crucible qualities nearing exhaustion, manufacturers are receiving a larger number of inquiries. The volume of orders from abroad for the cheaper classes of basic steel is steadily increasing, and indicates that German, Belgian and French competition is, though not wholly suspended, by no means keen. Prices continue firm and are unlikely to go below present figures. The fact that there is a slight reduction in the number of unemployed week by week in this district is evidence that the works are better occupied. The heavy branches are the quietest, but railway, electrical and motor-steel sections are better employed, while the tool branches have a fair lot of business on hand. In Scotland, steel bars are in fair demand, but competition for orders is keen, and considerable price-cutting is experienced. The sheet mills are turning out average outputs, chiefly for export, the home market remaining quiet, with buying on a limited scale. Confirmatory evidence of awakening activity in the steel trade is supplied in reports of the ferro-alloy market, especially as concerns home consumers. There is a fair demand for ferro-silicon, but buyers confine themselves chiefly to truck loads, as much through financial stringency as anything else, for while the price seems to be easy, there is little possibility of any real reduction on current quotations. In the tinplate market the orders in circulation are unimportant, and unless an improvement sets in shortly some of the works will have to close down a portion of the mills for want of new business. So far, makers are not pressing sales, and state that values cannot fall materially if cost of production is to be covered. The general tone of the market is poor, and quotations are easy for the standard size as follows:—Coke tins, IC 14 x 20, 112 sheets, 108 lbs., 19s. 1½d. to 19s. 3d. per box; IC 28 x 120, 112 sheets, 216 lbs., 38s. 6d. to 38s. 9d. per box; lights at ¾d. per lb. reduction; crosses at usual extras, net cash, f.o.b. Wales, say October-November delivery.

Scrap.

The slight improvement in the pig-iron trade, noted above, has not yet extended to the markets for scrap metal, which, on the whole, report stagnant if not depressed conditions. In Scotland, however, is found an exception to the general rule, business in the iron and steel scrap trade being fairly brisk, considering the state of trade generally. There are definite signs, moreover, that orders are being received by the works in limited increased numbers, and as a result the demand for all classes of scrap materials should improve. At Middlesbrough the only notable feature in the iron and steel scrap market has been a rather unexpected weakening in the price of heavy steel scrap. There is still a fair demand, but whereas as high a figure as 65s. was recently touched, the price now obtainable is no more than 62s. 6d., delivered works. Supplies of steel turnings and c.i. borings are short, and for the small quantities obtainable 49s. to 50s. per ton is paid. There is very little doing in other descriptions, and prices are approximately as follows, all delivered works:—Heavy cast-iron machinery scrap, 70s. to 75s.; heavy wrought-iron bushelling scrap, 52s. 6d.; ditto, piling, 60s.; special heavy forge, 70s. to 75s. per ton.

Metals.

Copper.—The tendency of the base metal markets of late has been to more restricted dealings, while fluctuations in values have been generally confined within a very narrow range. Demand for standard copper, however, has lately improved to a slight extent both for home consumption and on the Continent, and weekly sales have been well up to average. Reports from America show no great disposition on the part of producers to make sales of any substantial quantities of nearby metal, but purchases on forward account can be effected at a slight discount. Trade in this country appears to have taken a definite turn for the better, and consumers generally speak with more hopefulness with regard to the future. Current quotations:—*Cash*: Wednesday, £63 5s.; Thursday,

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£63 7s. 6d.; Friday, £63 2s. 6d.; Monday, £62 17s. 6d.; Tuesday, £62 12s. 6d. *Three Months*: Wednesday, £63 12s. 6d.; Thursday, £63 15s.; Friday, £63 10s.; Monday, £63 7s. 6d.; Tuesday, £63 5s.

Tin.—Conditions in the market for standard tin disclose little change during the current week, neither buyers nor sellers apparently taking any active interest in day-by-day dealings. There has been some weakening of demand of late in the Welsh tinplate trade, due probably to seasonal causes, and this may account for the corresponding slackness in this section of the metal market. Business with America continues on a restricted scale, but now that the labour situation is more promising, the demand from that quarter should show some improvement. The Straits have sold fair quantities during the past week, but Batavia is holding for higher values. Current quotations:—*Cash*: Wednesday, £159 2s. 6d.; Thursday, £159 10s.; Friday, £159 2s. 6d., Monday, £159; Tuesday, £158 15s. *Three Months*: Wednesday, £160 5s.; Thursday, £160 10s.; Friday, £160 5s.; Monday, £160 2s. 6d.; Tuesday, £159 17s. 6d.

Spelter.—The market for this metal continues firm, with values well held. Messrs. Henry Gardner & Company in their report state that, with little metal offering from the Continent, and with the American price above the London parity, the market remains dependent upon the demand from galvanisers for any further advance. Current quotations:—*Ordinary*: Wednesday, £31 12s. 6d.; Thursday, £31 17s. 6d.; Friday, £31 12s. 6d.; Monday, £31 12s. 6d.; Tuesday, £31 12s. 6d.

Lead.—Business passing in soft foreign pig is consistently steady, and the backwardation, recently so much in evidence, has now been reduced. Arrivals from Spain have been on a restricted scale, whilst supplies from Mexico have also been curtailed. The demand from consumers is being fairly well maintained, sheet and pipes makers taking fair quantities. Current quotations:—*Soft foreign (prompt)*: Wednesday, £24 7s. 6d.; Thursday, £24 7s. 6d.; Friday, £24 7s. 6d.; Monday, £24 10s.; Tuesday, £24 7s. 6d.

New Process of Finishing Welded Pipes.

A new process in the finishing of butt-welded pipes is described by MR. F. N. SPELLER (metallurgist of the National Tube Company, U.S.A.), who points out that while there have been many improvements in appliances for butt-welding pipe, the method of finishing has not been materially changed for some time. The new process involves welding the pipe larger in size than was formerly necessary, then after one rounding-up pass, the temperature of the pipe is reduced to a little above the annealing point (about 1,800 deg. Fah.), after which the diameter is further reduced by passing through several rolls to the finished size. The straightening and cooling operations are then carried out as heretofore. The object of these additional rollings is primarily to remove the welding scale from the pipe, especially from the inside, so as to lessen the tendency for pitting and facilitate galvanising or the application of other coatings. Incidentally, this additional work done on the steel tends to improve the material and the weld.

The standard method of finishing pipe formerly consisted in giving the pipe one pass through a circular sizing roll and one pass through straightening rolls of helical section and then cooling on a travelling table. The finished pipe was covered with a rather heavy mill scale formed in the heating furnace at the welding temperature. This scale consisted essentially of iron oxides, principally Fe_3O_4, with 7 or 8 per cent. of silica and smaller amounts of CaO and Al_2O_3 from the furnace bottom. At the welding temperature this scale was fluid and formed a natural flux for welding, as well as a protection to the metal against excessive oxidation from furnace gases, so that this was a very essential factor in the welding of pipe, so much so that pipe steel was made primarily so that it would be self-fluxing by readily forming this fluid oxide at as low a temperature as possible.

Several means have been used to remove this scale to prepare the pipe for galvanising and other coating operations. Pickling in acid is the most common method employed. Mechanical cleaning by sand blasting and cold rolling has also been tried, but has not been thorough enough, besides being costly.

By making the diameter of the pipe larger and then reducing its size and elongating the pipe at the highest temperature at which the scale is brittle enough to remove, it has been found possible to clean the pipe in the process of hot finishing and at the same time produce a better material in other respects. This new process of finishing is very advantageous. It will be seen that two additional steps are introduced in the finishing operation in order to produce what is practically a scale-free pipe, (1) a partial cooling from about 2,500 to 1,800 deg. Fah., (2) a reduction in diameter and elongation of about 10 per cent. in length by means of a series of horizontal and vertical rolls, by which the brittle scale is cracked and separated from the steel. The pipe is then straightened and cooled as usual, during which a thin film of new oxide forms sufficient to protect the metal from rusting while being handled. A thin coating of suitable lacquer is now applied, which affords substantial protection to the pipe in storage. The main object of these scale-removing and cleaning operations is to make possible more uniform galvanising. This also has an important bearing on the manufacture of all kinds of coated pipes and conduits for electrical purposes.

The surface rusts much more uniformly when scale-free than when covered with the heavy mill scale, as there is an appreciable current generated between mill scale and iron which results in pitting of the metal. For this reason it is usually of advantage to have the scale removed, especially where the pipe is buried in the ground or subject to other active corrosive agents. The fact that mill scale is usually the controlling factor with respect to pitting of iron and steel has been demonstrated by several other investigators.

The scale-removing process described was first developed in 1913, and has recently been put into general use in the butt-welding mills of the National Tube Company. In hot galvanising a saving of considerable time and about 50 per cent. of the acid has resulted from the use of scale-free pipe as well as a much improved product, particularly with respect to the inside coating.

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Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
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CUPOLAS

No. 1 GREEN'S CUPOLETTE, with 480 volt D.C. blower **£40**
2 ft. 6 in. ALLDAY'S CUPOLA, with belt-driven fan .. **£60**
3 ft. 6 in. WHITING CUPOLA, with spark arrester, as new **£95**
(Charging stage, hoist, and blower, to suit are in stock.)
2½-ton EVANS' CRANE LADLE, as new **£35**
EVANS' ½-ton CRANE LADLE, not geared, new .. **£14**
HAND LADLES and SHANKS, every size from 30 lbs. to 4 cwt. in stock, new and secondhand, **CHEAP.**
30 MOULDING MACHINES in stock, all types.
800 PAIRS OF MOULDING BOXES in stock, all standard and interchangeable, sizes as below:—

18" × 18",	5" tops,	5" bottoms,	18/- pair	150 pairs in stock
16" × 14",	4½" ,,	4½" ,,	16/- ,,	250 ,, ,,
18" × 12",	4" ,,	4" ,,	12/- ,,	200 ,, ,,
15" × 10",	4" ,,	4" ,,	12/- ,,	60 pairs, (pressed and steel)
12" × 12",	4" ,,	4" ,,	10/- ,,	60 pairs.

I supply every item of foundry equipment, both new and secondhand; am prepared to design and instal Foundry Plants Complete.

ALEXANDER HAMMOND,
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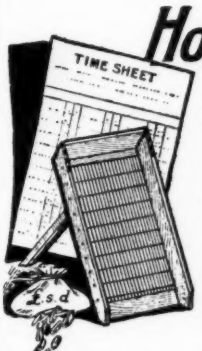

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WIRE screens are traps for material that clog continually, waste men's time and make a hole in your profits. You cannot afford this. Instal at once an

EXCELSIOR Steel Bladed SCREEN

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WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	62	12	6
Three months	63	5	0
Electrolytic	71	5	0
Tough	65	15	0
Best selected	65	15	0
Sheets	94	0	0
India	84	0	0
Wire bars	71	10	0
Do. Oct.	71	10	0
Do. Nov.	71	10	0
Ingot bars	71	7	6
H.C. wire rods	76	12	6
Off. aver. cash, Aug.	63	16	9 2/11
Do. 3 mths., Aug.	63	19	2 5/11
Do. Settlement Aug.	63	16	11 2/11
Do. Electro, Aug.	70	8	7 7/11
Do. B.S., Aug.	67	6	8
Aver. spot price, copper, Aug.	63	16	1½
Do. Electro, Aug.	70	18	7½

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10½d.
Yellow metal rods 6½d.
Do. 4x4 Squares 8½d.
Do. 4x3 Sheets 9½d.

BRASS.

Solid drawn tubes 11½d.
Brazed tubes 13½d.
Rods, drawn 10½d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. 10d.
Wire 9½d.
Rolled metal 9½d.

TIN.

Standard cash	158	15	0
Three Months	159	17	6
English	158	5	0
Bars	160	5	0
Chinese	157	5	0
Straits	159	0	0
Australian	159	0	0
Eastern	161	5	0
Banca	158	17	6
Off. aver, cash, Aug.	160	1	0 3/11
Do. 3 mths., Aug.	160	3	4 10/11
Do. Sttlment. Aug.	160	1	7 1/11
Aver. spot, Aug.	160	0	5½

SPELTER.

Ordinary	31	12	6
Remelted	30	0	0
Hard	24	0	0
Electro 99.9	34	10	0
English	31	15	0
India	24	10	0
Prime Western	31	15	0
Zinc dust	48	0	0
Zinc ashes	9	10	0
Off. aver., Aug.	30	16	3
Aver., spot, Aug.	31	3	5

LEAD.

Soft foreign ppt	24	7	6
English	25	5	0
Off. average, Aug.	24	3	10 4/11
Average spot, Aug.	24	11	8½

ZINC SHEETS.

Zinc sheets, English	37	10	0
Do. V.M. ex. whf.	38	10	0
Dutch	38	0	0
Rods	42	0	0
Boiler plates	35	10	0
Battery plates	36	0	0

ANTIMONY.

English regulus	25	15	0
Special brands	32	10	0
Chinese	23	10	0
Crude	14	15	0

QUICKSILVER.

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FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 12 5 0
75% 21 0 0

Ferro-vanadium—
35/40% 17/6 lb. va.

Ferro-molybdenum—
70/75% 8/9 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/1½ lb.

Ferro-phosphorus, 20/23%, £26

Ferro-tungsten—
80/85%, carbon free 1/6 lb.

Tungsten metal powder—
98/99% 1/9½ lb.

Ferro-chrome—
4/6% car. £32 0
6/8% car. £22 10
8/10% car. £22 0

Ferro-chrome—
Max. 2% car. £55
Max. 1% car. £68
Max. 0.70% car. £75
67/70%, carbonless 1/6½ lb.

Nickel—99%, cubes or pellets £150

Cobalt metal—98/99% 12/- lb.

Aluminium—98/99% £100

Metallic Chromium—
96/98% 5/- lb.

Ferro-manganese (net)—
76/80%, loose £15
76/80%, packed £16
76/80%, export £14 10

Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten s. d. 2 6
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb,
Flats under 1 in. by ⅛ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d
Heavy Steel	3	7	6	3	12	6
Bundled steel & shearings	2	17	0	3	5	0
Mixed iron & steel	2	17	6	3	2	6
Heavy cast iron	3	5	0	3	15	0
Good machinery for foundries				4	0	0

Cleveland—			
Heavy steel	3	2	6
Steel turnings	2	9	6
Cast-iron borings	2	9	6
Heavy forge	3	12	6
Bushelled scrap	2	12	6
Cast-iron scrap	3	12	6

Lancashire—			
Cast iron scrap	3	17	6
Heavy wrought	3	7	6
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	56	0	0
Brass (clean)	30	0	0
Lead (less usual draft)	21	0	0
Tea lead	18	0	0
Zinc	17	0	0
New aluminium cuttings	60	0	0
Braziery copper	46	0	0
Gun metal	40	0	0
Hollow pewter	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	97/6
Foundry No. 3	95/-
Forge No. 4	85/-
Mottled	82/-
Hematite No. 1	90/6
Hematite M/Nos.	90/-
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, foundry	—
,, Cold blast	240/-
,, basic	—
Northants forge	70/- to 72/6
,, foundry No. 3	77/6 ,, 80/-
,, basic	82/6
Derbyshire forge	75/-
,, foundry No. 3	82/6
,, basic	80/-
Scotland—	
Foundry No. 1	106/6
,, No. 3	101/6
Hematite M/Nos.	107/6
Sheffield (d/d district)—	
Derby forge	82/6
,, foundry No. 3	86/6
,, basic	—
Lincs. forge	86/6
,, foundry No. 3	86/6
,, basic	86/6
E.C. hematite	101/-
W.C. hematite	102/6
All d/d in the district.	
Lancashire (d/d eq. Man.)	—
Derby forge	—
,, foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	116/6
Glengarnock foundry	118/6
Gartsherrie foundry	118/6
Monkland foundry	116/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 15 to 11	10	0
Angles	£11 5 to 11	10	0
Tees to 3 united ins.	£11 15 to 12	5	0
Nut and bolt	9	17	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	0	0
Bolts and nuts, ½ in. × 4 in.	18	10	0

Steel—			
Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	10	0
Angles	£8 12 6 to 8	17	6
Tee	£9 12 6 to 9	17	6
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	10	0	0
Rounds, under 3in. to ⅝in.	9	10	0
Flats, over 5in. wide and up	10	0	0
Flats 5in. to 1¼in.	8	10	0

	£	s.	d.
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	16	10	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ½ in. dia	12	15	0
Billets, soft	7 0 0 to 7	2	6
Billets, hard	8	0	0
Sheet bars	6 17 6 to 7	7	6

PHOSPHOR BRONZE.

	Per lb. basis
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0¾
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round—	
3/0 to 10. G.	1/8½ to 2/3½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	34.14
No. 2 foundry Valley	33.00
No. 2 foundry, Birm.	23.00
Basic	31.96
Bessemer	33.76
Malleable	34.96
Grey forge	34.76
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	38.00
O.-h. billets	38.00
O.-h. sheet bars	38.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.32
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.60
Plain wire	2.35
Barbed wire, galv.	3.15
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry 35/- to 40/-
,, furnace 30/- to 32/6
Durham & North. foundry 28/-
,, furnace 23/6
Other Districts, foundry 27/6
,, furnace 22/-

SWEDISH IRON.

Bars, hammered basis sizes Basis price	£22 to £23
Rolled Ordinary— Assortment ..	£ s. d. 17 0 0
Nail Rods— Square, round and flats ..	to 17 10 0
Keg Steel nom.	£38 to £40
Faggot Steel nom.	£30 to £32
Blooms— Single welded ..	£10 to £11
Billets— Single and double welded	£13 to £14
Pig-Iron— Grey, white or mottled ..	£7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas ..	55%	Tube prices are now free.
Water ..	50%	
Steam ..	45%	

TINPLATES.

I.C.Cokes,	20×14, box	19/1½
,,	28×20, ,,	38/3
,,	20×10, ,,	28/-
,,	18⅞×14, ,,	19/6
I.X.	,	44/-
I.X.X.	,,	51/-
F.C.B.Y.	21×13⅝ ,,	37/-
C.V.B.G.	16¾×15, ,,	35/6
I.C.W.	20×14, ,,	16 10½
,,	28×20, ,,	33/6
,,	20×10, ,,	23/3
,,	18¾×14, ,,	17/3
Terneplates.	28×20, ,,	34/3

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Sept.13	63	5	0	inc.	2 6
,, 14	63	7	6	,,	2/6
,, 15	63	2	6	dec.	5/-
,, 18	62	17	6	,,	5/-
,, 19	62	12	6	dec.	5/-

Electrolytic Copper.

Sept.13	71	0	0	inc.	5/-
,, 14	71	10	0	,,	10/-
,, 15	71	10	0	No change	
,, 18	71	10	0	,,	
,, 19	70	10	0	,,	

Standard Tin (cash).

Sept.13	159	2	6	inc.	10/-
,, 14	159	10	0	inc.	7/6
,, 15	159	2	6	dec.	7/6
,, 18	159	0	0	,,	2/6
,, 19	158	15	0	,,	5/-

Tin (English ingots)

Sept.13	158	10	0	inc.	10/-
,, 14	159	0	0	inc.	10/-
,, 15	158	12	6	dec.	7/6
,, 18	158	10	0	,,	2/6
,, 19	158	5	0	,,	5/-

Zinc Sheets (English).

Sept.13	37	10	0	No change
,, 14	37	10	0	,,
,, 15	37	10	0	,,
,, 18	37	10	0	,,
,, 19	37	10	0	,,

Spelter (ordinary).

Sept.13	31	12	6	inc.	2/6
,, 14	31	12	6	No change	
,, 15	31	12	6	,,	
,, 18	31	12	6	,,	
,, 19	31	12	6	,,	

Lead (English)

Sept.13	25	5	0	dec.	5/-
,, 14	25	5	0	No change	
,, 15	25	5	0	,,	
,, 18	25	5	0	,,	
,, 19	25	5	0	,,	

There's something for You among these

Blacking, Coal Dust, Plumbago, Charcoal, Core Gum, Terra Flake, Gannister, Core Oils, Sea Sand, Moulding Sand, Iron Cement, Brushes, Bellows, Buckets, Chaplets, Core Ropes, Core Tapers, Ladles, Crucibles, Cupolas, Riddles, Sprigs, Spades, Carborundum Bricks and Wheels, Ferro-Aluminium, Blacking Bags, Foundry Plant, Etc., Etc., Etc.

F. L. HUNT & CO., 56, 58, 60, Chapel Street, Salford, Manchester.

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WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

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1, LALL BAZAR CALCUTTA.

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SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
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COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

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MOULDER REQUIRES STEADY AND PROGRESSIVE JOB. Accustomed to complete control. Motor and General Engineer and Jobbing. Personally operating Cupola and other Furnaces, making oil-sand jacket cores, and supplying castings to analysis. Iron, Aluminium and Bronze. Good Technical and Practical: Mathematics, Mechanics, Chemistry, Physics, Metallurgy, Iron and Steel Manager and Mechanical Drawing. Good knowledge of costs, and could assist in Drawing Office, Pattern Shop or any department of Foundry. I.B.F. and B.C.I.R.A. Man. — Apply: F. A., c/o Ignition Laboratory, 57, Union Street, Oldham, Lancs.

ADVERTISER, Age 39, seeks position as Non-ferrous FOUNDRY MANAGER. Twenty-five years' practical experience. Thorough knowledge of up-to-date plant and practice. Unimpeachable references. Address, in first instance, Box 212, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PATTERN FOREMAN, 7 years U.S.A., expert knowledge and supervisory ability; competent to take charge of any shop. A1 references, desires situation.—Address, Box 254, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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Catalogue of Stock Machinery, 5-6,000 Lots.
Free on Application. Inspection Invited.

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ALBION WORKS,
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NEW WELDING PLANT, with Acetylene Generator, six blowpipes, etc., ready for use, £17 5s.; complete new Cutting Plant, £15 10s. Lists free.—STANSELL'S ACETYLENE COMPANY, LIMITED, Exeter.

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CUPOLA, new, Thwaites No. 6 Rapid, capacity 5-6 tons per hour, with all improvements, f.o.r. Dudbridge, near Stroud. BLOWER, "Acme" (new) by Samuelson & Company, Limited, (exclusive motor), Brookhirst motor starting panel wall mounting, suitable for starting motor against full load, torque frequently; suitable for the above Cupola; f.o.r. Dudbridge, near Stroud. Reasonable offer accepted.—Box 256, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY —*Contd.*

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